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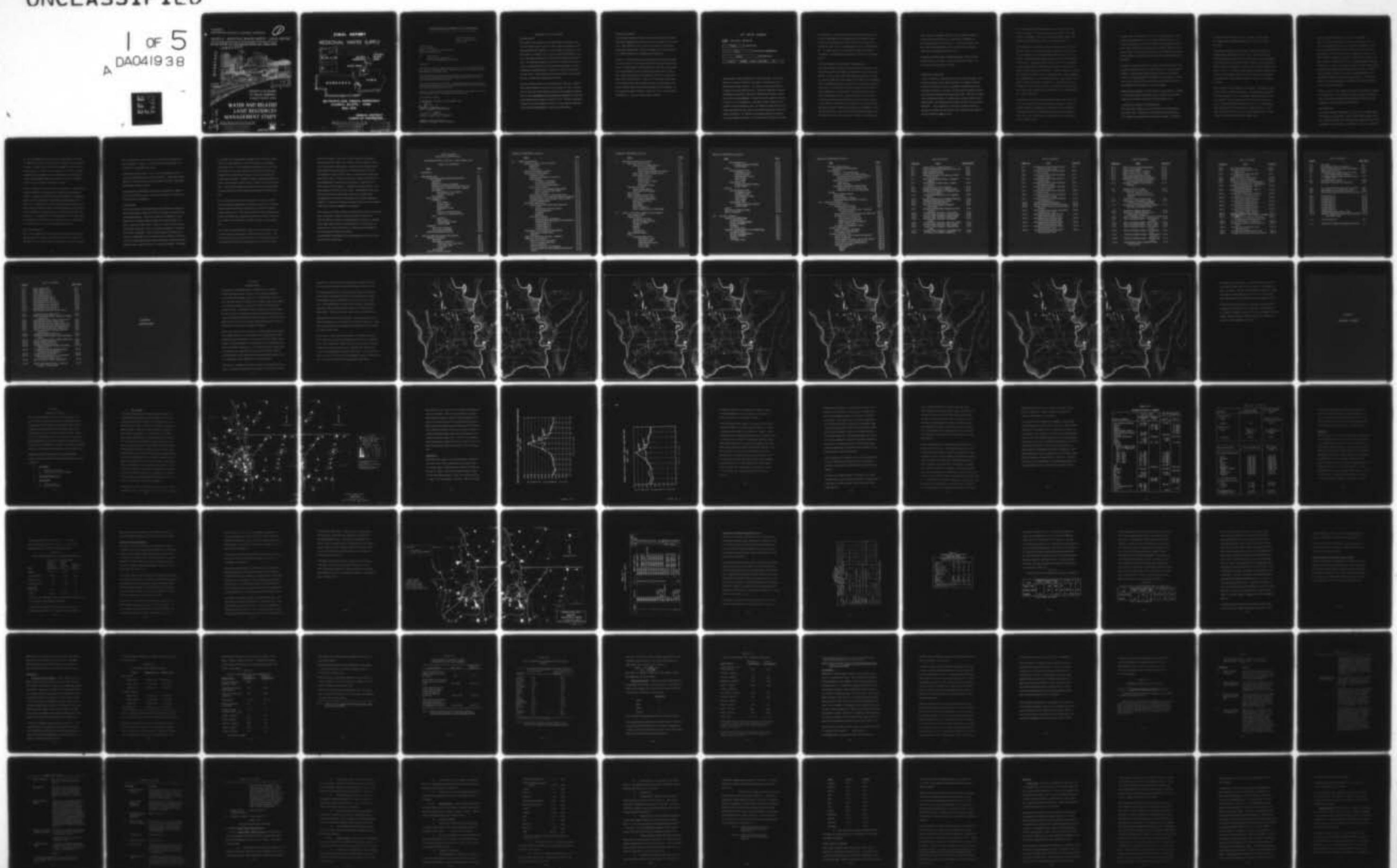

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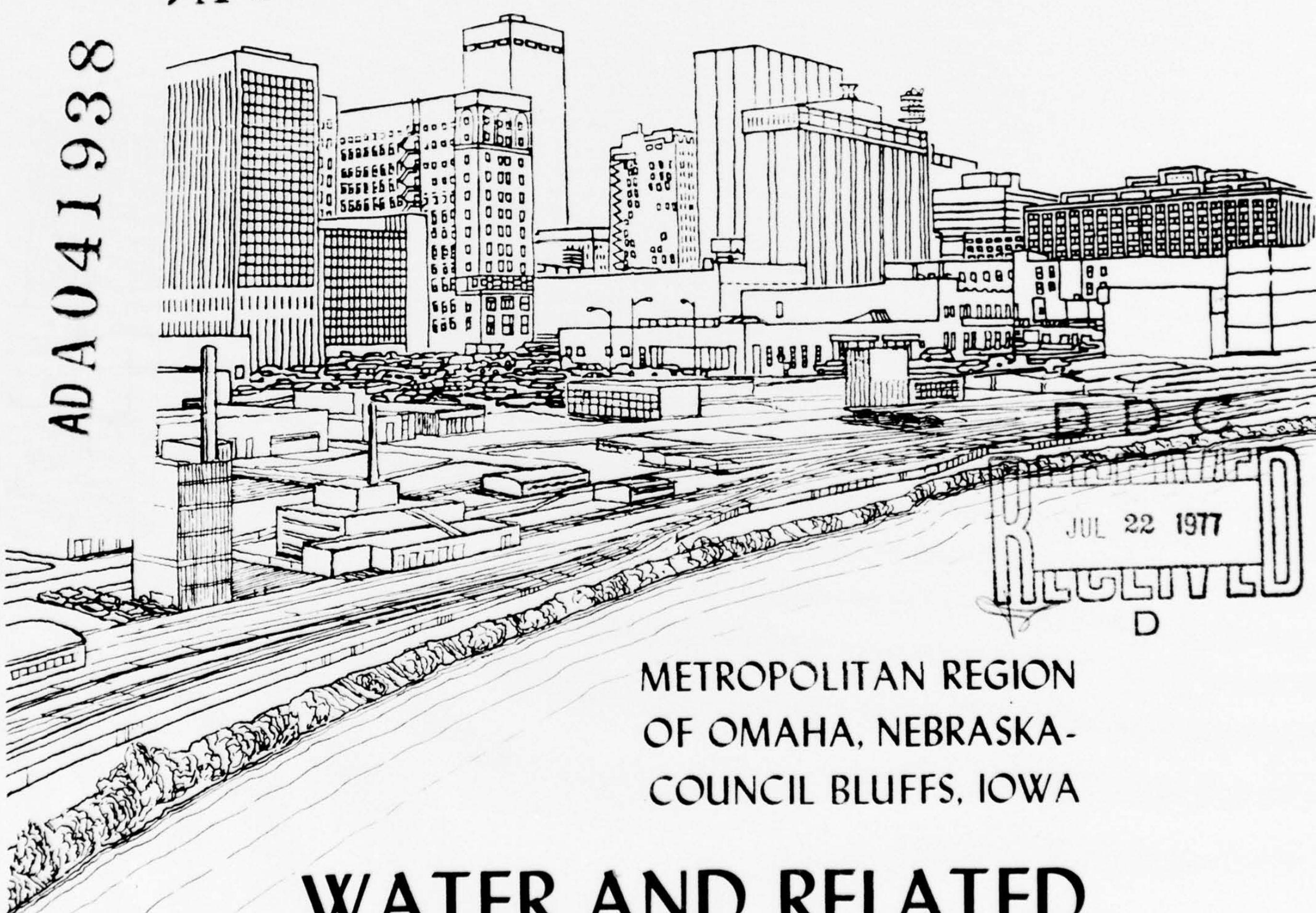

METROPOLITAN REGION
OF OMAHA, NEBRASKA-
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WATER AND RELATED LAND RESOURCES MANAGEMENT STUDY

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JUNE 1975

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(9) **FINAL REPORT**

REGIONAL WATER SUPPLY

(6) Water and Related Land Resources Management Study. Volume V. Supporting Technical Reports Appendix. Annex K. Regional Water Supply.

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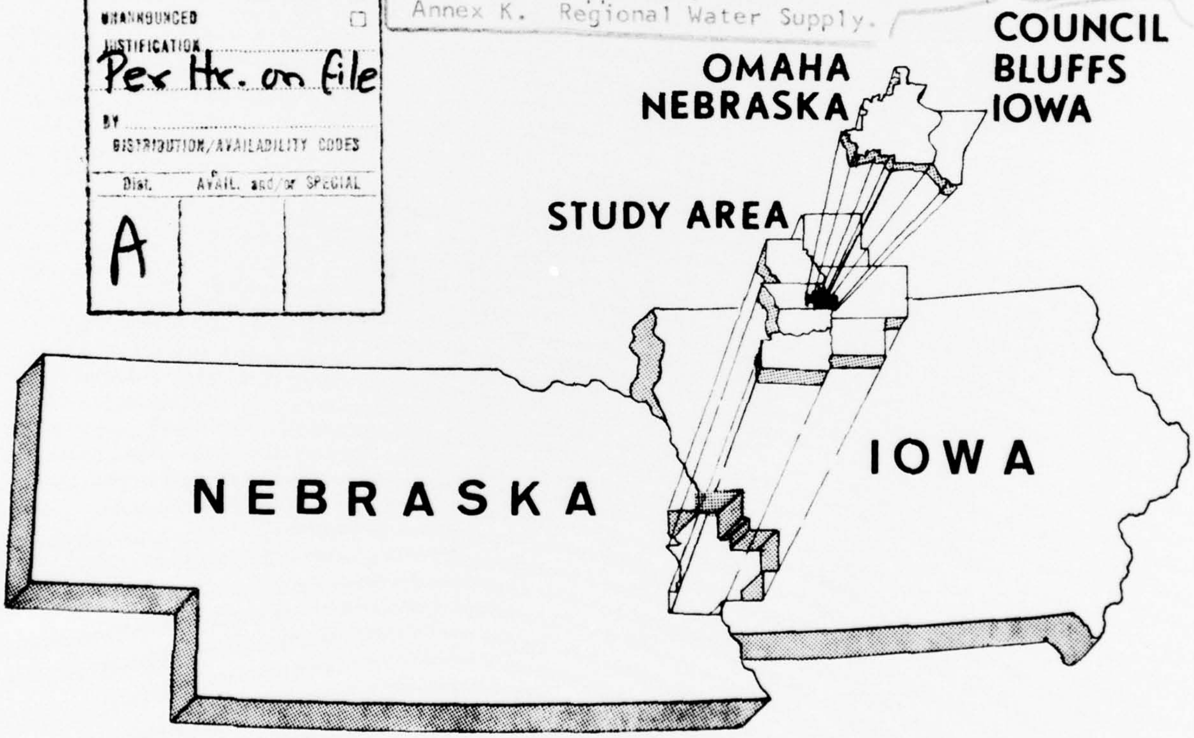

METROPOLITAN OMAHA, NEBRASKA-COUNCIL BLUFFS, IOWA
MAY, 1975

OMAHA DISTRICT
CORPS OF ENGINEERS

HENNINGSON, DURHAM & RICHARDSON

ARCHITECTURE · ENGINEERING · SYSTEMS · PLANNING · ECO-SCIENCES

8404 Indian Hills Drive
Omaha, Nebraska 68114
May 1, 1975

Omaha District
Corps of Engineers
6014 U. S. Post Office and Court House
Omaha, Nebraska 68102

Re: Final Report
Regional Water Supply Study
Metropolitan Omaha-Council Bluffs

Gentlemen:

In accordance with our engineering contract, we are herewith submitting our report on the Regional Water Supply Program for Metropolitan Omaha, Nebraska-Council Bluffs, Iowa.

The major findings and recommendations have been abstracted from the report and are briefly discussed in the Summary and Conclusions which precede the main body of the report.

The report consists of two volumes. The appendix provides supplemental background information for the investigations, findings and recommendations that are presented in the main report.

We have enjoyed working with the Omaha District on this study and look forward to being of service to you again in the near future.

Respectfully submitted,

HENNINGSON, DURHAM & RICHARDSON, INC.

Paul R. Ombruni, Vice President

Robert D. Catton, Project Manager

Charles C. Plummer, Project Engineer

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SUMMARY AND CONCLUSIONS

INTRODUCTION

The purpose of the Regional Water Supply Study is to conduct a survey and evaluate growth concepts of water supply components for the Metropolitan Omaha, Nebraska - Council Bluffs, Iowa vicinity. The total study area includes Cass, Douglas, Sarpy and Washington Counties in Nebraska, and Harrison, Mills and Pottawattamie Counties in Iowa. The ultimate objective of the study is to determine the water resource requirements associated with alternate growth concepts, to develop and evaluate alternative solutions to water and related land resource needs, and to integrate single-purpose water resource function into an urban water management program.

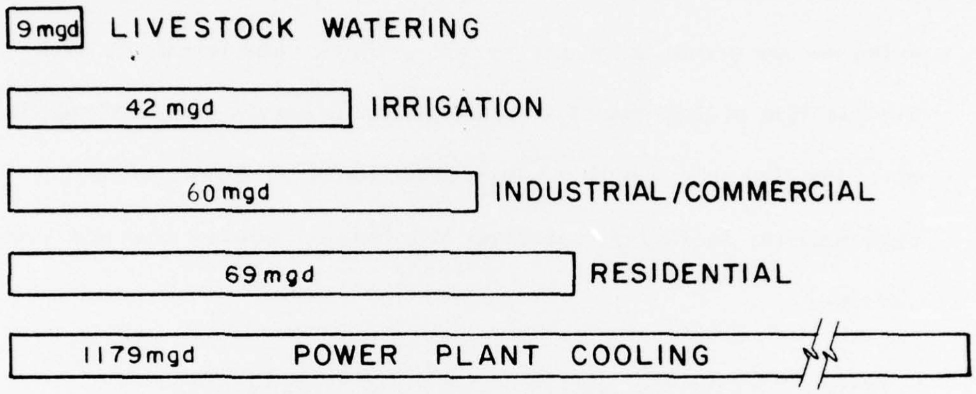
The Safe Drinking Water Act, officially named "Title XIV - Safety of Public Water Systems" became law on December 17, 1974. Its objective is to provide for the safety of drinking water supplies throughout the U.S. by establishing and enforcing national standards. Interim primary standards were issued on March 14, 1975. The final provisions of this act may have significant impact on considerations within this report and on implementation of report recommendations.

REGIONAL SUMMARY

The Omaha Metropolitan Utilities District (MUD) and Council Bluffs City Water Department are the two major water suppliers in the study area. They supply 86 percent of the area's present municipal and rural water requirements. These two supplies are treated and meet U.S. Public Health Service Drinking Water Standards.

There are 53 other municipal type water supply systems in the study area, 42 of which do not meet the Health Service Drinking Water Standards. In most instances, the standards are exceeded in the amounts of iron and manganese that are found in the ground waters of the region. These ground water well supplies are found to be from moderately hard to extremely hard. There are 27 municipal systems that do not disinfect their water supplies; however, this amounts to only about 6 percent of the present total municipal and rural demand. Of the municipal systems evaluated, only three have the desired system reliability and meet all drinking water standards.

1973 WATER DEMANDS



The presently available institutions for providing water service to the study area consist of municipal corporations, special districts and privately owned water systems. The political and legal problems encountered in extra territorial service, interlocal cooperative ventures, consolidation of districts, and policy considerations relevant to water service have been investigated. Certain factors are apparent from the reserach: (1) It is possible to create water systems which serve beyond the corporate limits of a city. (2) Utilities located within a municipal corporation may, by contract, be extended beyond the territorial limits of the policy. (3) Interlocal cooperation beyond state boundaries is permissible and, indeed, is encouraged by the Intergovernmental

Cooperation Act. (4) A body of case law has been developed over the years sustaining the constitutionality of most extraterritorial schemes for providing water service, which case law deals with the question of the duty of a municipality to serve, rate differentials, etc. (5) There are policy considerations which direct toward regionalism, including functional efficiency, reduced cost and better service.

FUTURE QUANTITY AND QUALITY REQUIREMENTS

Based upon present trend water usage predictions, percapita rural and municipal water consumption is expected to increase 37 percent by 2020. This increase coupled with population projections results in a predicted 2020 water usage equal to 2 1/2 times 1973 consumption. Future municipal water usage is expected to be 31 percent industrial-commercial, 13 percent out-of-house residential and 56 percent in-house residential. Non-agricultural rural demands will increase with the introduction of safe, reliable rural water system service. Agricultural livestock watering demand will nearly triple reaching 23 mgd in 2020. Quantities of water used for crop irrigation will be dependent upon state regulatory agency policy in granting new irrigation well and surface water diversion permits and based upon available data will increase by 73 percent to 73 mgd on a yearly average

basis. Major self-supplied industries using substantial quantities of water which may affect future regional water availability are power generation and coal gasification. Upstream irrigation could have serious detrimental effects upon regional water availability (Platte River) and quality (Missouri River).

Alternative growth concepts substantially influence water demand centers, however, the effect of alternative growth concepts on the total study area water demand is minor.

WATER USE REDUCTION

Various concepts for reducing water use have been investigated. Non-structural concepts include public education for voluntary reduction programs, incentives to attract low quantity industrial water users, legislative alternatives, and water pricing policies including the metering of individual apartment and mobile home units. Structural concepts involve mechanical devices, including water-saving and water-eliminating toilets, flow reduction shower heads and water-saving washing appliances. Also considered are dual water systems requiring a separation of potable and non-potable water employing both traditional and non-traditional supply sources.

The use reduction concepts investigated cover a wide range of techniques and methods. Likewise, these concepts involve a wide range of public acceptability, costs, and technical feasibility. Some of the concepts are interdependent; others are mutually exclusive.

The Consultant has realistically considered the potential for effectuating the various use reduction concepts in relation to expected results. It is the judgment of the Consultant that in general, non-structural alternatives should be given a higher priority, structural alternatives a lower priority. Among structural concepts, water conserving fixtures and dual supply systems which do not incorporate wastewater reuse should receive the greatest consideration. System reliability, economics and unanswered health concerns in conjunction with a relative abundance of good quality water, serve to preclude serious consideration of wastewater recycling for general use at this time. It is the opinion of the Consultant, however, that the technical considerations are not unsolvable; large-scale wastewater reuse may therefore be a viable alternative in the distant future.

Considering the 1995 projected demand for potable water in the study area, it is estimated that a use reduction of as great as 23 percent could be realized by employing the concepts of selective industrial development, metering of individual apartments and mobile homes, use of water conserving fixtures, and application of pricing policies to the resultant quantity.

A potable water use reduction as great as 33 percent could be realized by also incorporating the use of dual water systems in new and redeveloped residential areas with lawn watering and toilet flushing requirements being satisfied by a non-potable water supply. With such a dual system, water conserving toilets would not affect potable water demand but would reduce sewage flows an average of 15 percent per applicable household.

In addition, voluntary actions toward water conservation could increase the above estimated reductions in potable water use. A large measure of public acceptance and voluntary support will have to be obtained, however, if the above potential reductions are to be realized. Certain legal actions would also be necessary to permit and facilitate the implementation of some of the use-reduction concepts.

Industrial water demands are often reduced to some extent as a method of reducing wastewater treatment cost since industry is now usually required to contribute significantly to waste handling costs.

ALTERNATIVE SOURCE CONSIDERATIONS

The major water supply sources in the study area are the Missouri and Platte Rivers. Omaha and Council Bluffs both utilize Missouri River surface sources as their primary water supply. The absolute

minimum flow for the Missouri River is 5,000 cfs (3,250 MGD). This supply would more than adequately serve the entire needs of the region.

Of particular significance are the tentative findings regarding the available water supply from the Platte River. The Missouri River Basin Commission's Platte River Level "B" Study, while not completed, does indicate that the lower Platte River would be "dried-up" by additional irrigation development for periods of one or more months during future dry years. If even the existing Platte River water supply sources for the cities of Omaha and Lincoln are to be protected, an effective management and "protected flow" system for Nebraska is an absolute necessity.

Other sources of water supply were investigated. Wastewater, storm runoff, water treatment process water, and power plant cooling water have been considered. Use of wastewater and storm runoff in a dual water system concept is examined in detail in the following two sections. Treatment plant filter backwash recycle can be accomplished at the Omaha and Council Bluffs water treatment facilities. Power plant cooling water may be used as a partial supply source to curtail winter freezing problems at surface supply sources.

RURAL-URBAN WATER SUPPLY CONCEPT PLANNING

Four area-wide water supply and distribution plans have been developed and evaluated with respect to four urban growth futures. Based upon the assumption that rural water districts of some form will eventually serve most of the study area, Supply Plan I features rural water districts developed in county-wide reports in four counties and under study and construction in a fifth. Metropolitan Omaha and Council Bluffs are served as recommended in their respective master plans with the Missouri South new site option for MUD in Plan I. Plans II and III evaluate two steps of increased regionalization and source centralization along the Platte and Missouri Rivers. Use of a dual potable - non-potable supply and distribution system in new growth areas is considered in Plan IV.

Design criteria for water supply components are developed and applied to the Supply Plans. Presedimentation sludge handling is included as a part of treatment facilities although uncertainty exists as to final regulations regarding disposition of this waste.

COST ANALYSIS

Unit costs normalized at September 1974 are used to compute capital and maintenance and operation costs for major water system components: supply, treatment, and sludge handling facilities; booster pumping stations; storage facilities; and pipelines. Costs are computed for

the various Supply Schemes and a present worth analysis performed to establish a basis for a cost comparison of Supply Plans and Growth Concepts. Present worth costs indicate rankings from least to most costly as Plans II, III, and I and Concepts C, B, D, and A. Average monthly billings computed for non-metropolitan areas indicate little variance among Supply Plans and a reduction of costs in Growth Concept B due to an increase in the number of users.

Costs are computed for several specific considerations. The economics of public supply water softening versus individual home softening is verified. Economics of ground versus surface supplies are examined with the conclusion that other considerations dictate supply source in most cases. Analysis of the costs of a dual distribution system versus potable supply treatment savings indicates that under present and foreseeable conditions, dual systems are not economically feasible in the study area. A comparison of costs demonstrates considerable savings in development of a Platte West site rather than a Missouri South site as a third major source for the metropolitan Omaha area.

EFFECT ASSESSMENT

Alone, water supply has not and probably cannot control urban growth patterns within the study area. However, when used in conjunction with other services such as sewers, transportation, schools, and police

and fire protection, a powerful tool in controlling and regulating land use is available. Pricing is one of the most effective and easily utilized items in controlling water usage.

Constrained growth is found to reduce water consumption and hence costs principally through reduced lawn irrigation. Constrained growth futures are less affected monetarily by Platte River water availability than westward sprawl concepts.

Regionalization of distribution system and centralization of supply in rural areas optimizes usage of chemical and manpower resources and increases energy consumption.

CONCLUSIONS

It is the conclusion of this study that the rural-urban water supply and distribution system as outlined in Plan II is the plan of preference with certain qualifications. Economics verify the desirability of a major supply source developed along the Platte River west of Omaha. In order to make use of this source, however, priority of claims among other Platte Valley users, and/or streamflow regulation or augmentation must be established. Water priority planning at the State level must be accomplished in the immediate future to determine legal claim of water by Platte Basin entities and the feasibility of streamflow maintenance by water control structures or interbasin transfer. A Missouri

River South site is the alternative supply source if the above considerations are not resolved in a manner favorable to metropolitan Omaha water needs. Environmental concern indicates that the Missouri South site may not be situated on the Gifford Peninsula near Fontenelle Forest while this particular area has been found to be economically desirable. Hopefully a Missouri South site could be obtained in the Bellevue vicinity if lack of a Platte River source necessitates. Surface water quality degradation due to upstream wastewater discharge makes well field development presently preferable at this site.

Water systems will generally be developed on a county-by-county basis to facilitate institutional arrangements. However, every effort should be made to eliminate county lines as a barrier to economic, reliable water service. The Missouri River acts as a natural barrier between interstate water systems but connections between county systems within each state should be available at least on an emergency basis.

The Omaha Metropolitan Utilities District is the institutional vehicle for water system development in Douglas and Sarpy Counties. The Papio Natural Resources District provides an existing framework for a Washington County System purchasing water from MUD and Blair.

In Harrison County, a rural water board comprised of municipal representatives and county commissioners will be required to implement and operate a county supply, treatment and distribution system. Membership in the Metropolitan Area Planning Agency gives rural Pottawattamie County and Mills County, an institutional arrangement upon which to build. Water purchased from Council Bluffs would supply Pottawattamie County while development of a county source in Mills County would be required. Existing rural water districts cover approximately two-thirds of Cass County. Municipalities within these districts not desiring membership at the time of initiation may eventually find it desirable to participate even if system expansion is required. A fourth Cass County rural water district for the remainder of the county would be supplied from Louisville.

Total capital cost outlay to 2020 for implementation of the recommended plan is estimated to range from $524,216,000 for Concept B to $529,906,000 for Concept C to $598,847,000 for Concept A. Although total capital outlay is less for Concept B than C, more money is required prior to 1995 in Concept B for construction and expansion of the new town and satellite city systems.

Average billing requirements per non-metropolitan user will be in the $20 to $30 per month range.

FINAL REPORT
REGIONAL WATER SUPPLY

Metropolitan Omaha, Nebraska - Council Bluffs, Iowa

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SECTION I

INTRODUCTION

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The purpose of the Regional Water Rupply Study is to conduct a survey and evaluate growth concepts of water supply components for the Metropolitan Omaha, Nebraska - Council Bluffs, Iowa vicinity. The total study area includes Cass, Douglas, Sarpy and Washington Counties in Nebraska, and Harrison, Mills and Pottawattamie Counties in Iowa. The ultimate objective of the study is to determine the water resource requirements associated with alternate growth concepts, to develop and evaluate alternative solutions to water and related land resource needs, and to integrate single-purpose water resource function into an urban water management program.

Objectives of the study are (1) conduct a regional summary of existing water supply systems, (2) review political and legal aspects for planning and operating institutions, (3) project future water supply requirements, (4) develop methods of reducing water use, (5) determine feasibility of alternate supply sources, (6) develop alternative supply plans, (7) determine costs associated with alternative plans and concepts, (8) assess effects of the alternative growths and plans considered, and (9) recommend a water supply future for the study area.

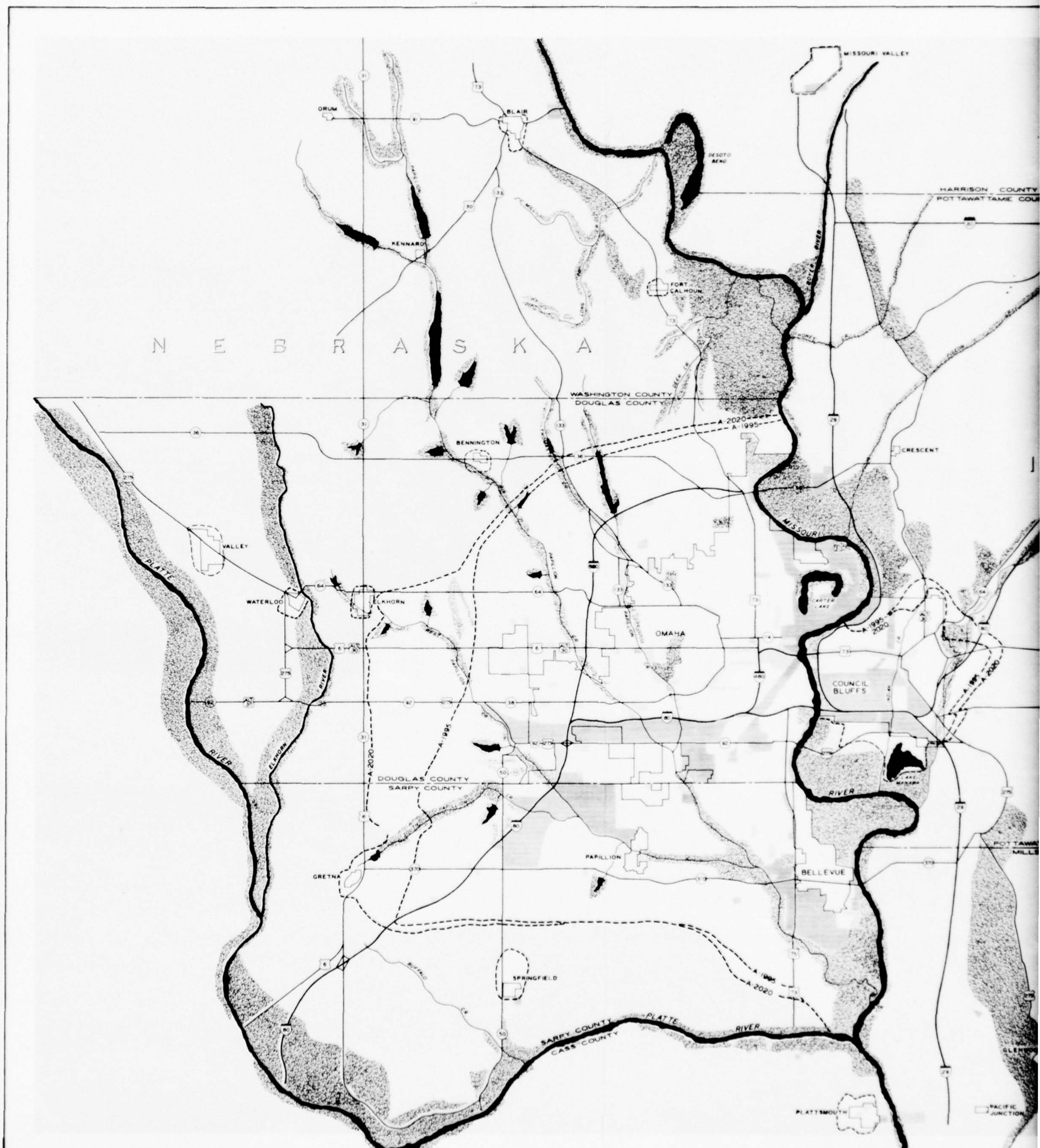
This study, in conformance with the provisions of the Engineering Contract, is conceptual in approach and schematic in design. The study is

supported by a collection of basic quantitative and qualitative data, the majority of which has been obtained through secondary sources.

The tasks performed by the Consultant and the data presented herein have been accomplished with the goal of providing water supply planning that is future oriented and creative for the seven-county area. The Consultant has contacted various Federal, State and local agencies and collected data that pertain to the Regional Water Supply Study. This data has been evaluted and is presented herein.

Population forecasts and four alternative urban growth patterns (see Plates following) have been provided by the Corps of Engineers. These land use patterns have been the basis for development of the urban water supply requirements.

This project is being conducted through the Urban Studies Program and is under the direction of the Department of the Army, Omaha District, Corps of Engineers. This Program seeks to provide a range of urban water resource plans that are compatible with comprehensive urban development goals of the region under study. The Corps of Engineers, on June 26, 1974, directed Henningson, Durham & Richardson, Inc., of Omaha to commence with the Regional Supply Study.



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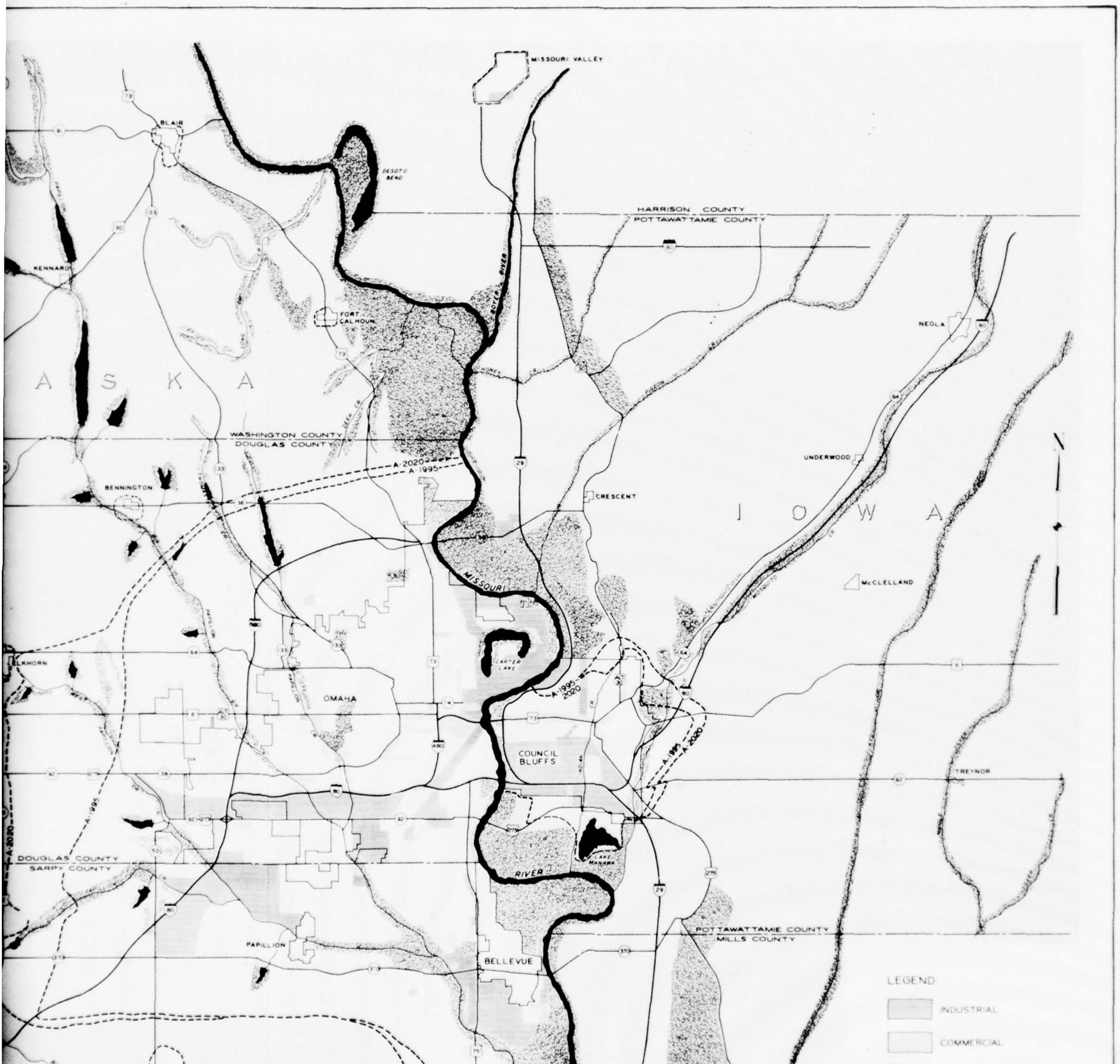

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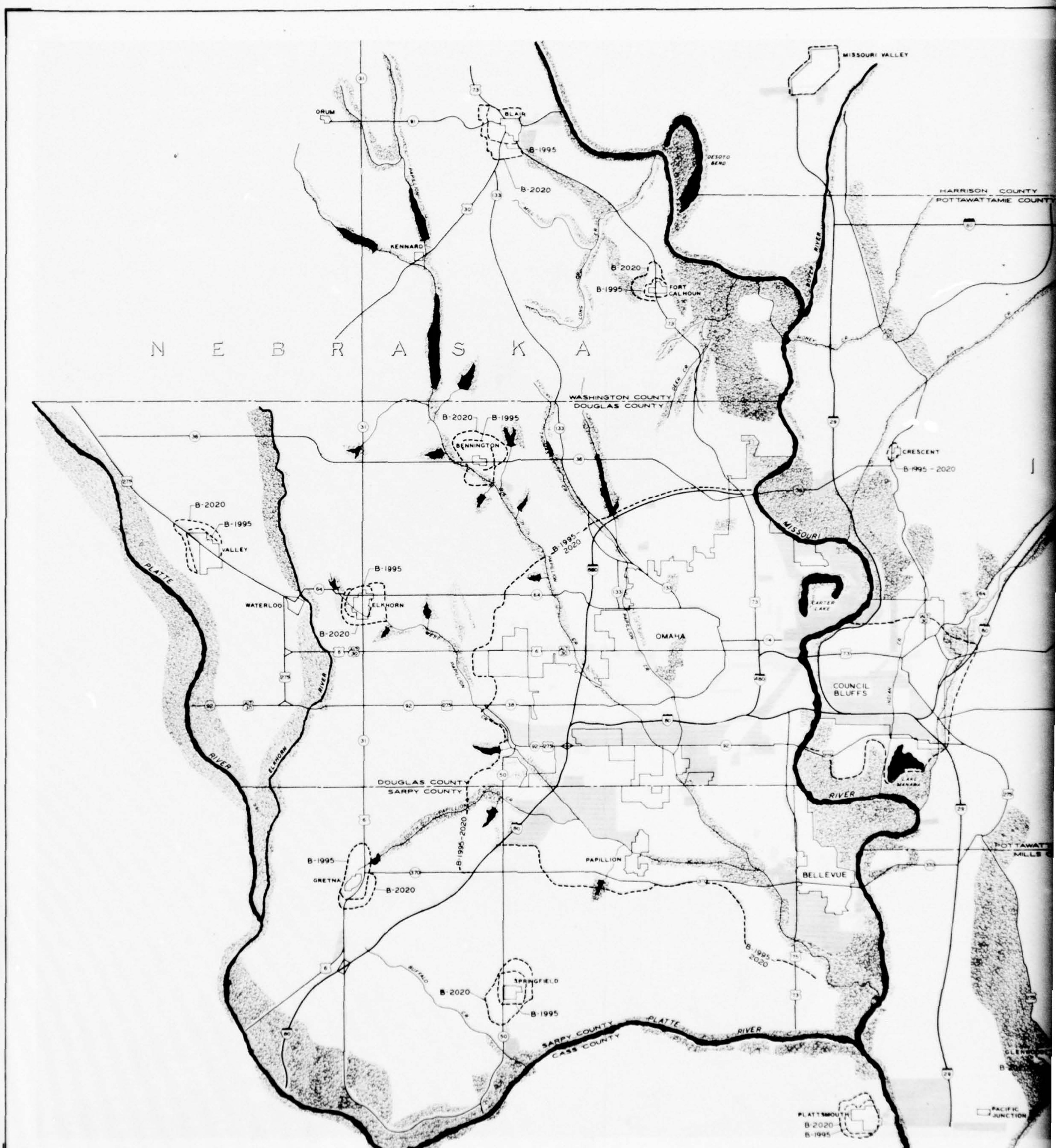

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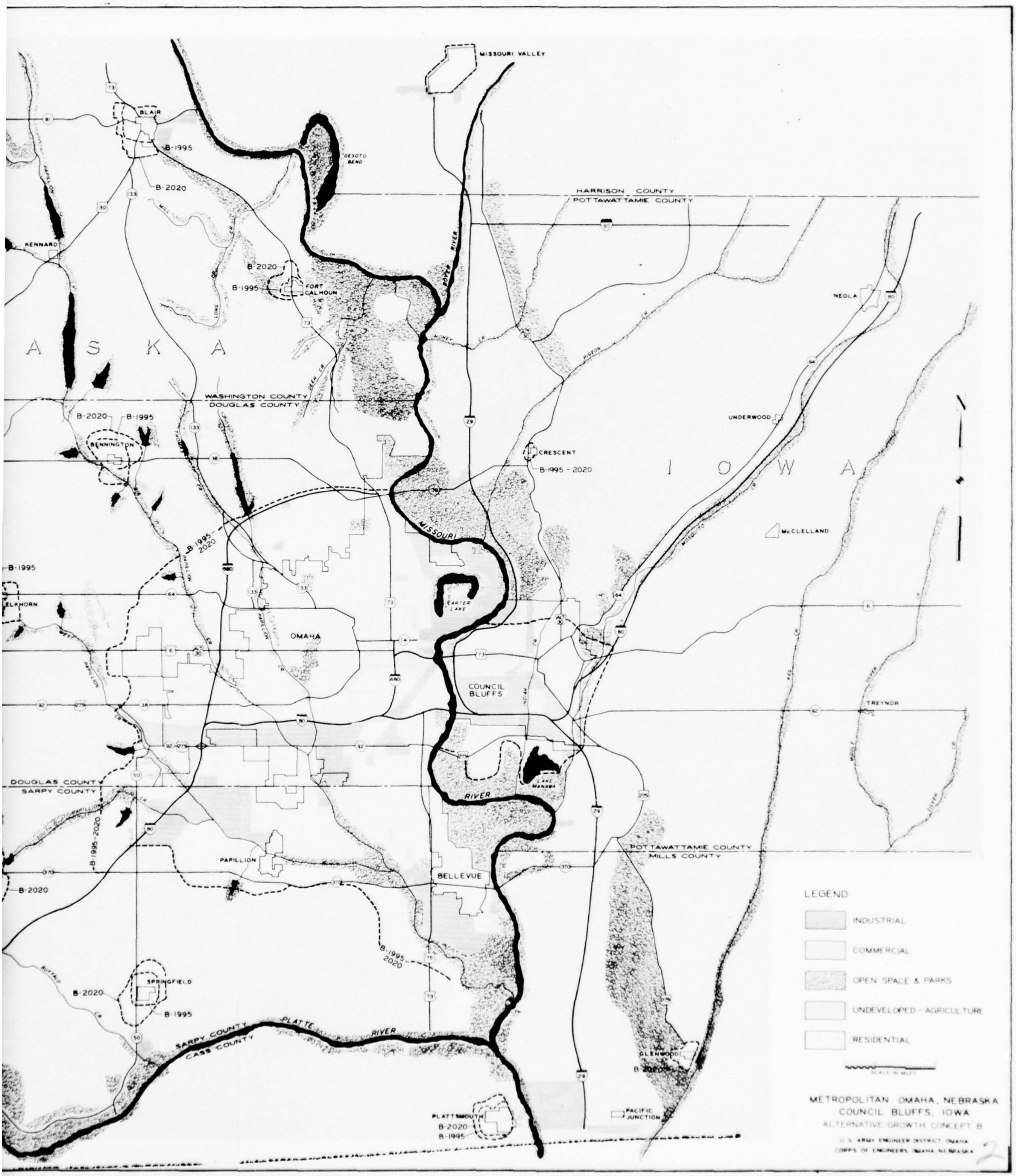
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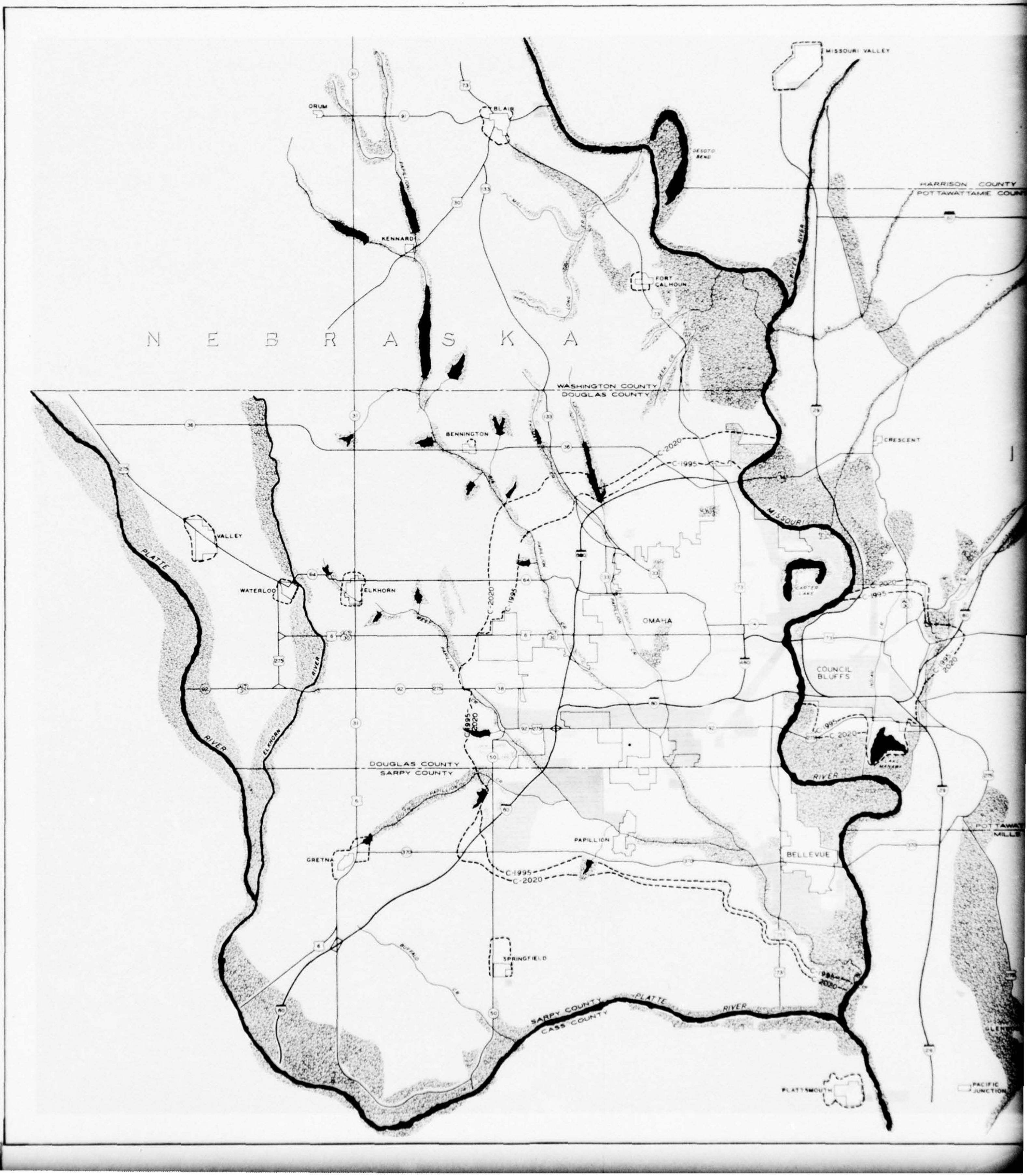

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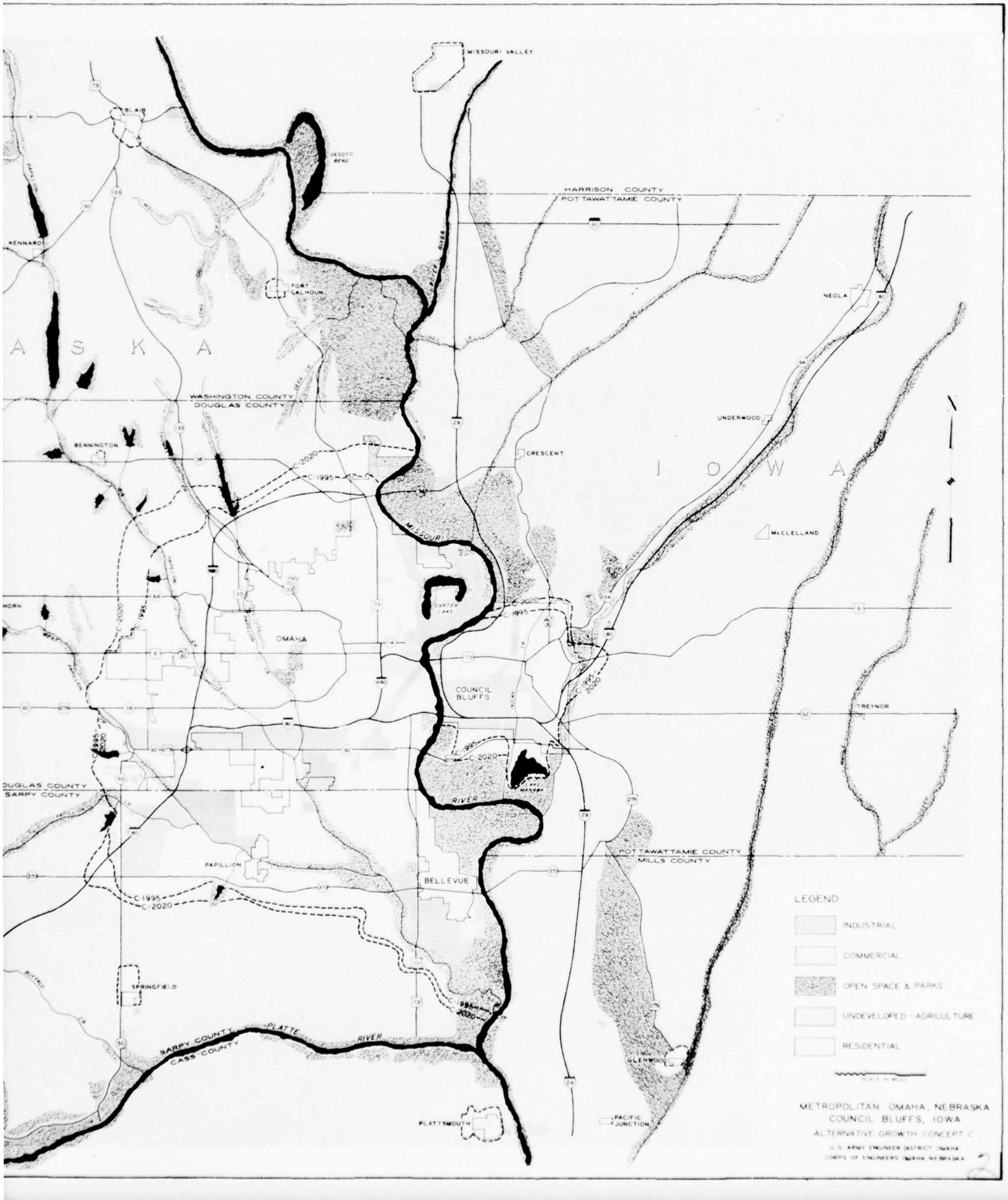
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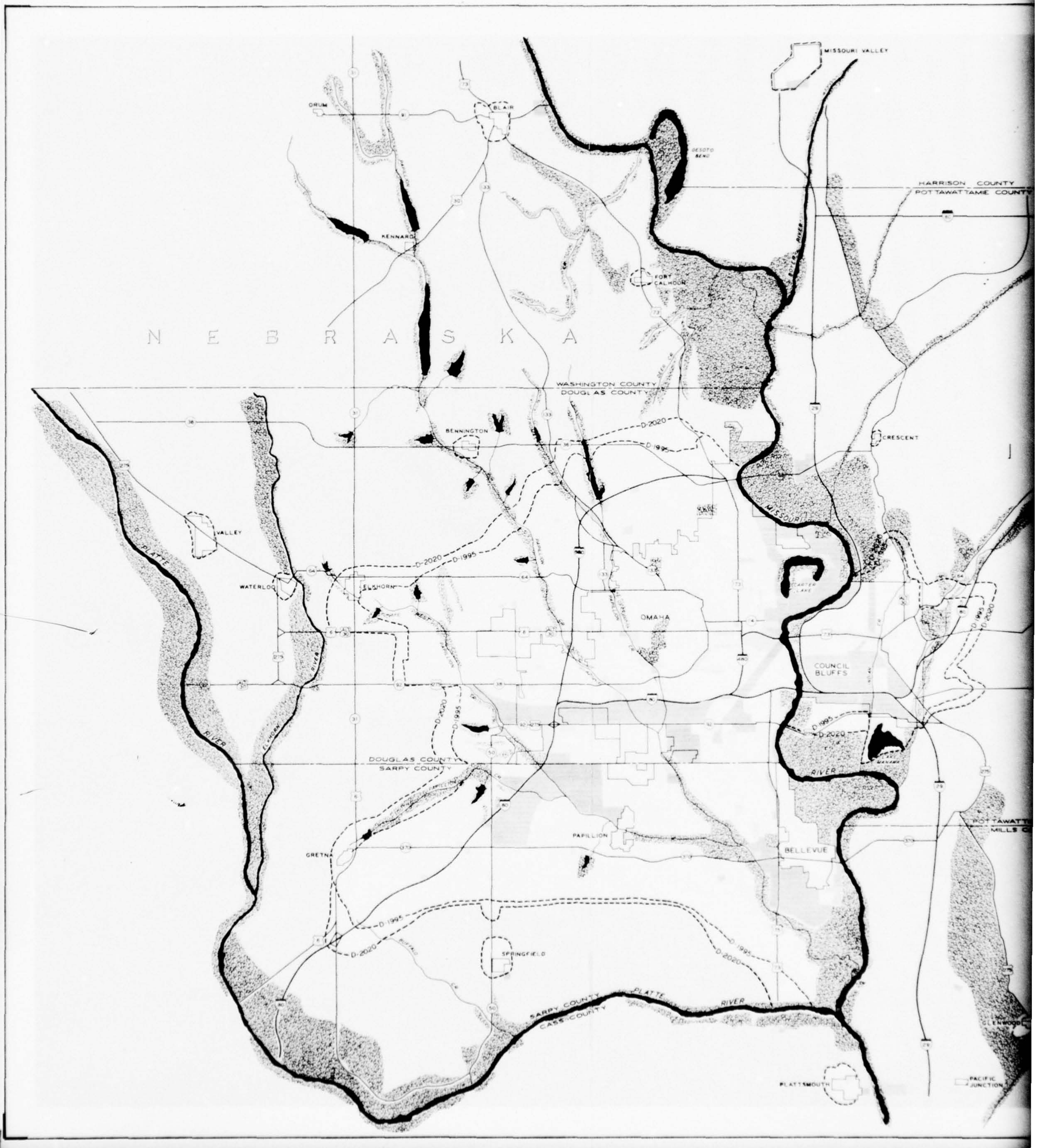

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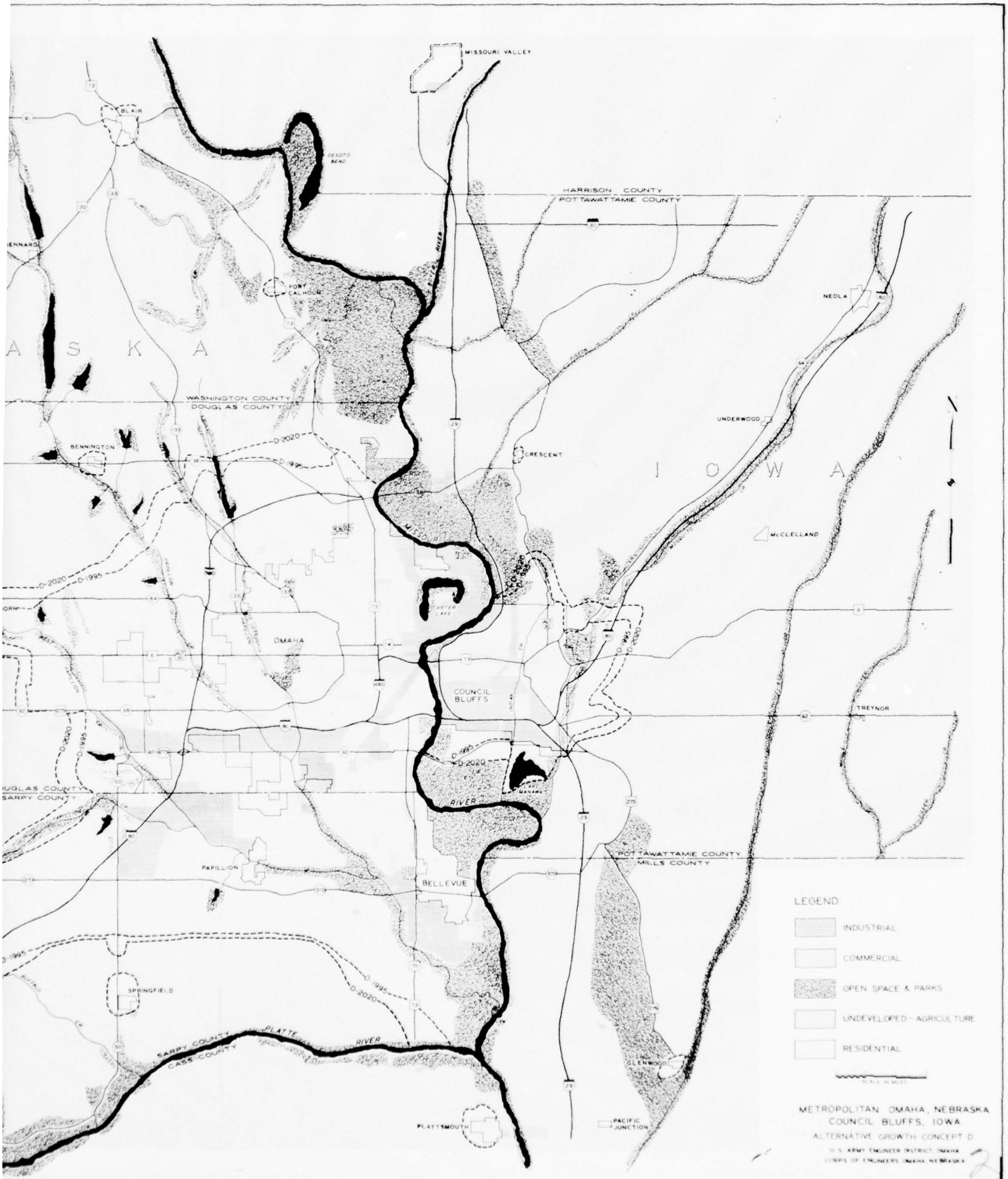
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METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
ALTERNATIVE GROWTH CONCEPT D
U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA NEBRASKA
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During the course of the study, excellent cooperation has been received from Federal, State and Local agencies, consulting engineers, and others. Specific acknowledgment is made to the Omaha Metropolitan Utilities District and to the City of Council Bluffs Water Department for their assistance in the compilation of data.

Political and legal aspects have a significant bearing in the final development of a regional water supply plan. Investigations by Dr. Richard E. Shugrue, Professor of Law at Creighton University, Omaha, Nebraska deal with these aspects and are presented as Section C of the Appendix to this report.

SECTION II

REGIONAL SUMMARY

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REGIONAL SUMMARY

This section summarizes current (1973) water usage in the seven county study area and the systems supplying this water. A large portion of the information contained in this section is a summary of other engineering and planning reports and questionnaires sent out in conjunction with this study. Where two or more information sources on the same area contain conflicting information, the most recent source was generally used. Where no direct information is available, estimates are computed based on values obtained from similar classes of water users.

PRESENT QUALITY AND QUANTITY REQUIREMENTS

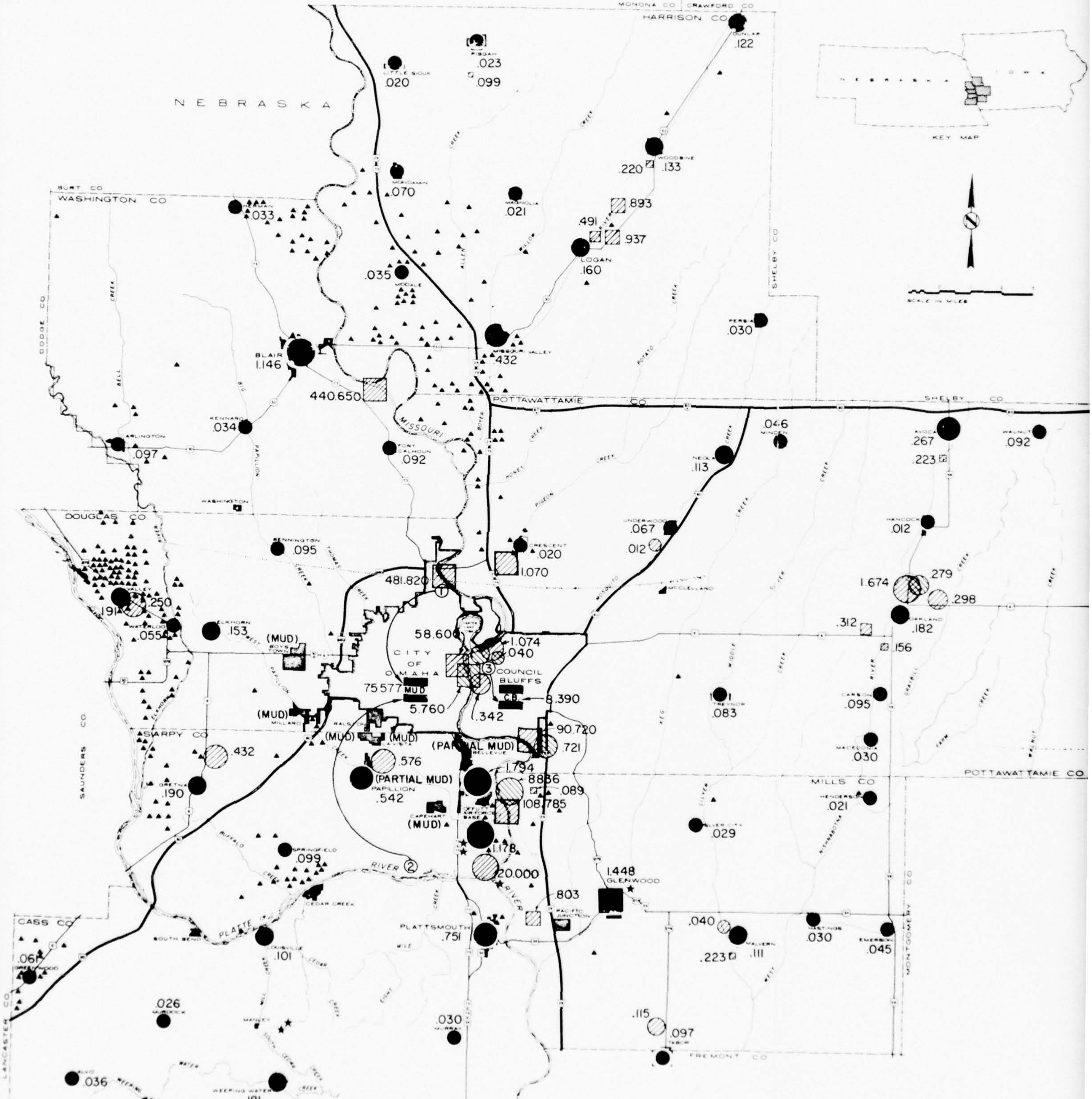
Water use was determined for the following categories and subcategories:

1. Residential
   a. In-house or domestic.
   b. Out-of-house or lawn irrigation.
2. Industrial/Commercial
3. Agricultural
   a. Crop irrigation.
   b. Livestock watering.

4. Recreational

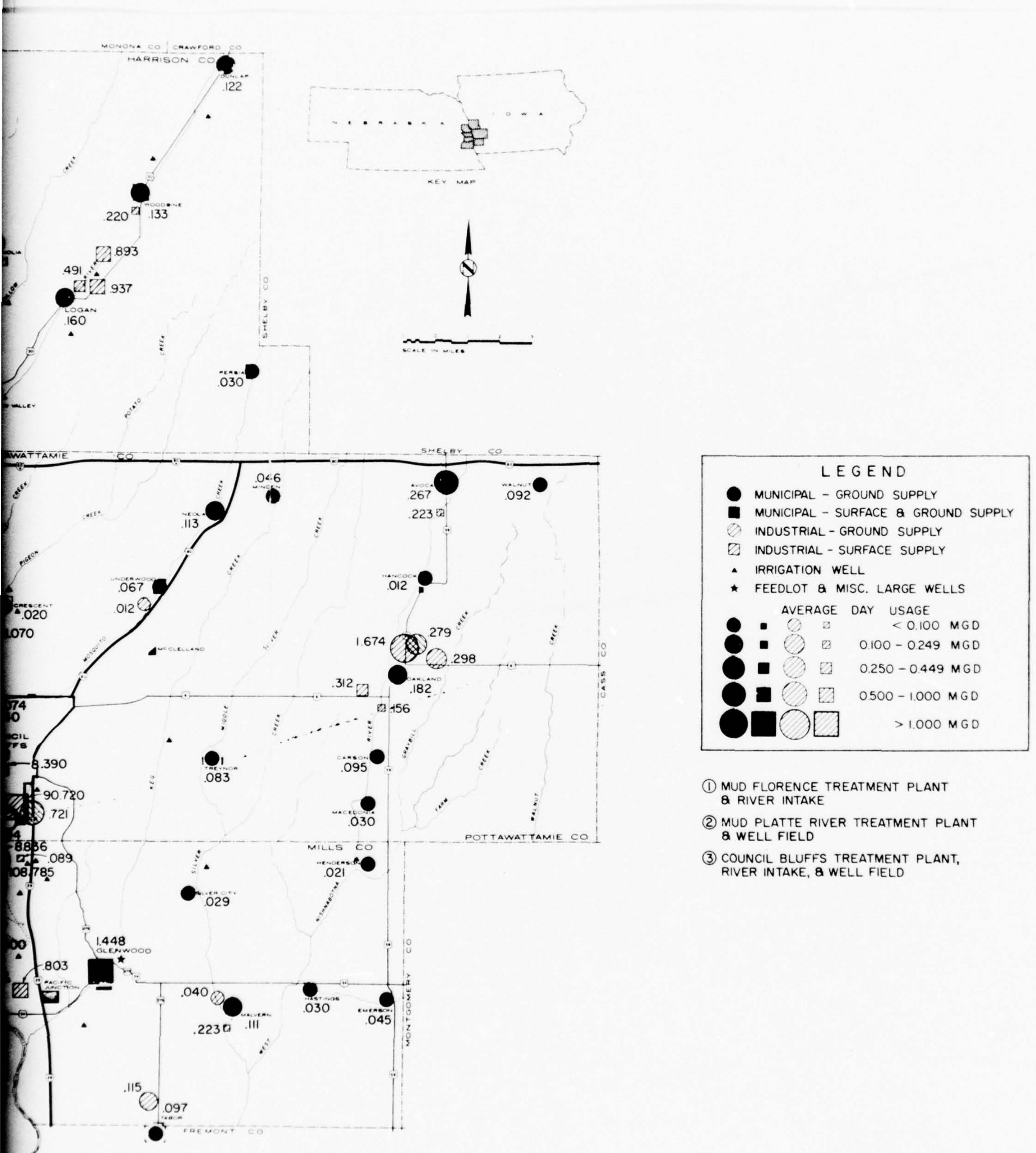
Available information for all municipal supply systems, except the Omaha Metropolitan Utilities District, includes all commercial and industrial usage in one category and all residential usage in another. MUD billing categories include residential, general commercial, large commercial, general industrial and large industrial. In this study as in the MUD Water System Master Plan, the general commercial category will be included in the residential usages since general commercial users and usages are more typical of residential than industrial users. General commercial users are those small businesses and services which tend to reflect population trends, are dispersed throughout the city, and have comparatively low usage per connection. Thus in current and future usage figures, where a differentiation is made between municipally served industrial and residential, the industrial category will include all water usage reported as industrial, wholesale, city, and commercial except in the Omaha MUD system where general commercial usage will be included with residential.

Through out this report the terms current or existing refer to conditions in 1973. A base date of 1973 is used because this was



REGIO

U.S.
CORPS OF



REGIONAL WATER SUPPLY

USER MAP

U.S. ARMY DISTRICT OMAHA

CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE II-1

the last full year for which data was available at the time this report was initiated. MUD and Council Bluffs records for 1974 which have become available in the final stages of this study are of interest because of the extreme hot and dry conditions which prevailed during an extended period in summer, 1974. Figures II-2 and II-3 illustrate by means of month-by-month average daily usage comparisons the pronounced consumption increase in July 1974 vs. July 1973. In the MUD system maximum day usage rose from 157 mg in 1973 to 173 mg in 1974 and peak usage from 240 mg in 1973 to 283 mg in 1974.

Residential

Residential water usage, as previously defined, constitutes 70 percent of the 1973 average day municipal water usage in the study region. Residential water usage in the MUD system was 53.1 mgd, in the Council Bluffs system 4.5 mgd, in other municipal systems 8.5 mgd, and in private systems 3.3 mgd - for a total regional residential usage of 69.4 mgd.

METROPOLITAN UTILITIES DISTRICT (MUD) MONTHLY WATER CONSUMPTIONS
1973 - 1974

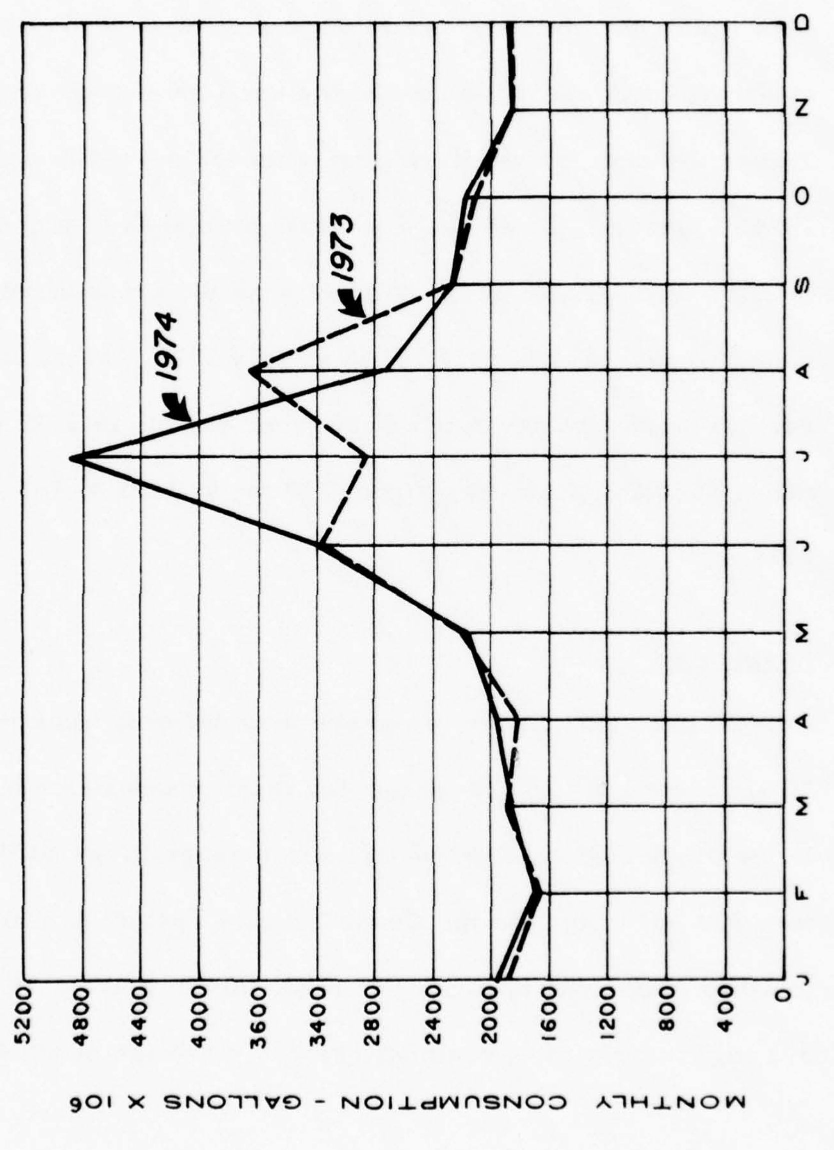


FIGURE II - 2

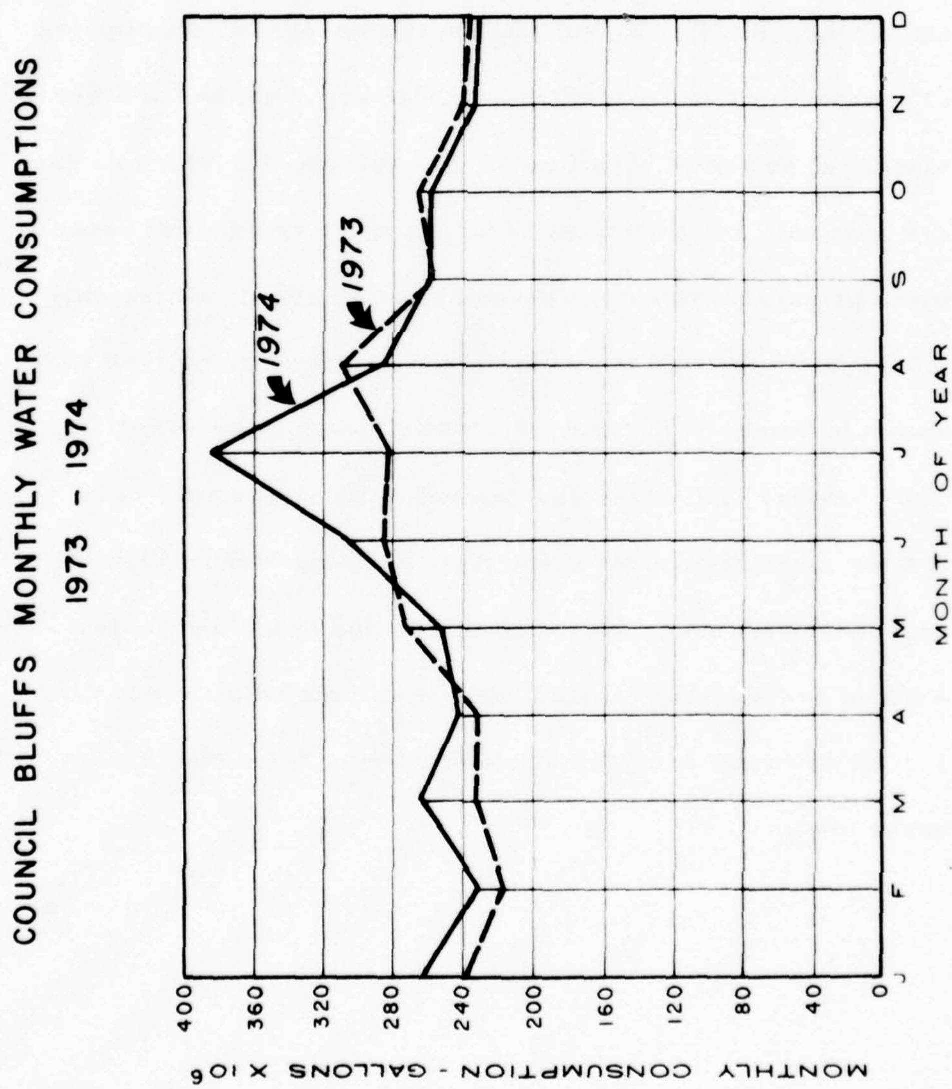

COUNCIL BLUFFS MONTHLY WATER CONSUMPTIONS
1973 - 1974
1974
1973
400
360
320
280
240
200
160
120
80
40
0
J
F
M
A
M
J
J
A
S
O
N
D
MONTH OF YEAR
MONTHLY CONSUMPTION - GALLONS X 10^6

FIGURE II - 3

Residential usage in 1973 ranged from a high of 123 gpcpd in the MUD system to a low of 60 gpcpd in the private systems with a study area average of 110 gpcpd.

Actual residential water usages are available only for MUD and Council Bluffs. Actual total system usages and estimates of non-residential usages are available for a number of other municipal systems. Small municipal systems for which no data are available are estimated at 90 gpcpd for residential usage while private systems are estimated at 60 gpcpd. Where only total system demand is available and no major industries were known to exist, 90 percent residential usage is assumed. The peak day to average day demand ratio is assumed to be 2.0 for small municipal and private systems without significant industrial users for which this factor is not available. Peak to average day demand ratio is calculated to be about 1.3 for in-house use and approximately 6.0 for out-of-house use.

Residential water usage was subdivided into in-house or domestic and out-of-house (principally lawn irrigation) categories to help quantify potable and non-potable residential water usage. The in-house and out-of-house categories do not correspond directly with potable and non-potable usage since only a small portion of that water used within a household is actually ingested. However, essentially all of the out-of-house usage is for non-potable purposes and could be more readily adapted to a separate non-potable supply than in-house uses. Detailed analysis of in-house water usages and their adaptability to non-potable water supplies are contained in later sections of this report.

Lawn irrigation as a residential use is very important since it varies considerably from household to household and is generally a major factor in high peak day and peak hour consumption.

In-house uses, whether potable or non-potable, are more constant from area to area depending mainly on supply source (municipal or private) and have more uniform day-to-day usage patterns.

Lawn irrigation and other out-of-house uses account for about 20 percent of residential water usage in the MUD system and 15 percent or less in Council Bluffs and the other municipal and private systems. These percentages were determined by assuming that the difference between average winter usage and average yearly usage is due to lawn irrigation. On peak days lawn irrigation constitutes 52 percent of the residential and 38 percent of the total water usage in the MUD system.

Quality requirements associated with lawn watering are primarily aesthetic in nature. While highly saline water or water containing toxic materials would be unacceptable for lawn irrigation, as well as crop irrigation, the most likely problem associated with a non-potable lawn watering supply would be public acceptance and public health. An odorous or unsightly water would not be publicly acceptable. Bacteriologic quality of the water would have to be high because of the possibility of ingestion of the non-potable supply, especially by an uneducated public. Essentially any raw water acceptable as a potable water supply could be used with minimal treatment for lawn irrigation. Use of wastewater for lawn irrigation would require treatment

beyond present definitions of secondary treatment to insure public acceptability. Further discussion on wastewater reuse is presented later in this report.

United States Public Health Service (USPHS), 1962 Drinking Water Standards are summarized in Table II-1. While USPHS standards are commonly used as a guideline for the water treatment industry, the standards are intended only to prohibit interstate carriers from obtaining potable water not meeting quality requirements. Provisions of the Safe Drinking Water Act (PL93-523) require the director of the Environmental Protection Agency (EPA) to promulgate drinking water standards. While these standards are not yet available, they will probably closely follow the proposed standards listed in Table II-1. The EPA is also given the responsibility of promulgating design and construction standards for use by the water treatment industry.

TABLE II-1

DRINKING WATER QUALITY STANDARDS

Chemical Substance	U.S.P.H. 1962 Recommended Limit	U.S.P.H. 1962 Mandatory Limit	EPA 1974 (Proposed) Esthetic	EPA 1974 (Proposed) Health
Alkyl benzene sulfonate	0.5 mg/l		0.5 mg/l	
Arsenic	0.01 mg/l	0.05 mg/l		0.1 mg/l
Barium		1.0 mg/l		1.0 mg/l
Cadmium		0.1 mg/l		0.1 mg/l
Carbon-Alcohol Extract				3.0 mg/l
Carbon-Chloroform Extract	0.2 mg/l			0.7 mg/l
Chloride	250 mg/l		250 mg/l	
Chromium (hexavalent)		0.05 mg/l		0.05 mg/l
Color	15 mg/l		15 mg/l	
Copper	1 mg/l		1 mg/l	
Cyanide	0.01 mg/l	0.2 mg/l		0.2 mg/l
Fluoride (Annual average of max. daily air temperatures of)				
50.0 - 53.7	1.2 mg/l		1.2 mg/l	
53.8 - 58.3	1.2 mg/l		1.1 mg/l	
58.4 - 63.8	1.0 mg/l		1.0 mg/l	
63.9 - 70.6	0.9 mg/l		0.9 mg/l	
70.7 - 79.2	0.8 mg/l		0.8 mg/l	
79.3 - 90.5	0.7 mg/l		0.7 mg/l	
Iron	0.3 mg/l		0.3 mg/l	
Lead		0.05 mg/l		0.05 mg/l
Manganese	0.05 mg/l		0.05 mg/l	
Mercury				.002 mg/l
Nitrates	45 mg/l		45 mg/l	
Odor	3 T.O.N.		3 T.O.N.	
Phenols	0.003 mg/l			
Selenium		0.01 mg/l		0.01 mg/l
Silver		0.05 mg/l		0.05 mg/l
Sodium				270 mg/l
Sulfates	250 mg/l		250 mg/l	
Total dissolved solids	500 mg/l			
Turbidity	5 FTU			1 FTU
Zinc	5 mg/l		5 mg/l	

TABLE II-1 (cont'd)

Radiologic	U.S.P.H. 1962 Recommended Standard	EPA 1974 Proposed Health
Alpha Activity		
Gross		0.5 pc/l or 5 pc/l when Ra 225 <0.5 pc/l
Radium	3 pc/l	0.5 pc/l
Beta Activity		
Gross	1000 pc/l in absence of stro- tium	5 pc/l or (50 plus K40) when Sr90<5
Strontium	10 pc/l	5 pc/l

Pesticide Herbicide	U.S.P.H. Guideslines	1974 Proposed Health
Chlorinated Hydrocarbons		
Aldrin	0.017 mg/l	0.001 mg/l
Chlordane	0.003 mg/l	0.003 mg/l *
DDT	0.042 mg/l	0.050 mg/l
Dieldrin	0.017 mg/l	0.001 mg/l
Endrin	0.001 mg/l	0.0005 mg/l
Heptachlor	0.018 mg/l	0.0001 mg/l
Heptachlor Epoxide	0.018 mg/l	0.0001 mg/l
Lindane	0.056 mg/l	0.005 mg/l
Methoxychlor	0.035 mg/l	0.1 mg/l
Toxaphene	0.005 mg/l	0.005 mg/l *
* limit based on odor		
Chlorophenoxy Herbicides		
2,4-D	0.1 mg/l	0.02 mg/l
2,4,5-YP	0.1 mg/l	0.03 mg/l
2,4,5-T	0.1 mg/l	
Organophosphate and Carbamate (total)	0.1 mg/l (parathion)	0.1 mg/l (parathion)

Water quality requirements for the major in-house non-potable use of toilet flushing are primarily aesthetic in nature. A detailed discussion of in-house water uses and their quantity and quality requirements is contained in the section of this report on water use reduction and reuse.

Industrial

Industrial water use historically constitutes a major portion of total quantity of water used. Water is used for cleaning, as a transport media, coolant, source of steam and as an ingredient in many food products. The majority of large industrial users are located within the Omaha-Council Bluffs Metropolitan Area where transportation access, availability of a skilled labor force and adequate utilities facilitate growth. Industrial water use comprises approximately 31% of Omaha's total water use in 1973 (Table II-2). Council Bluffs exhibits a similar percentage. Small villages and cities do not possess the capability of providing large industrial users with an adequate supply of water or the necessary

transportation links to support growth. As a result, only a small portion of the total water use outside of the Metropolitan Area is used for industrial purposes.

TABLE II-2

CITIES WITH A SIGNIFICANT INDUSTRIAL WATER USE

City	1973 Avd. Day (MGD) Industrial and Commercial Use*	1973 Avg. Day (MGD) Total Municipal Use	Percent Industrial Use
Omaha	23.363	76.433	31
Council Bluffs	3.867	8.390	46
Malvern, Iowa	.052	.111	47
Glenwood, Iowa	.775	1.266	61
Remaining Study Area	1.238	9.126	14
Totals	29.295	95.326	31

*Industrial and commercial usage is equivalent to industrial use in the context of this Industrial Summary.

Industrial water demand for Metropolitan Omaha-Council Bluffs represents 93% of total industrial demand exhibited

within the seven county study area. On a study wide basis, industrial demand constitutes 31% of total municipal water usage.

Industrial Location and Supply

Selection of a source of water that is economically amenable to industry in terms of availability and quality governs the siting of many industrial plants. Within the metro-area, many large users locate in industrial tracts with an adequate source of supply (MUD or Council Bluffs) to minimize pumping and distribution costs. Similar considerations apply to industrial users located outside the metro area.

Due to large volume usage and varied water quality requirements, some industries find it more desirable to develop their own source of supply rather than purchase water from a municipal system. Such self supplied industries tend to locate near water supply sources that are favorable in terms of providing the necessary quality and quantity of water for given processes.

Heavy users of cooling water locate adjacent to major rivers where sufficient quantities of water are readily available. A river location also provides the user with an accessible receiving water for discharge of return cooling waters. In recent

years, however, the practice of discharging cooling water to a receiving stream has become an item of concern. The effect of thermal discharge on stream biota is the subject of numerous ongoing studies. Cooling water represents the major portion of total industrial withdrawals.

Industries which require high quality process and boiler make-up water must consider treating the municipal or raw water to an acceptable level of quality.

Major self-supplied industries within the study area engage in chemical manufacturing and power generation. Power plants along the Missouri River withdrew 1179 mgd in 1973, 99% of which was used for cooling purposes. This cooling water was drafted directly from, and subsequently returned to the Missouri River after cooling operations. Evaporation losses did not significantly reduce the quantity of water being returned to the resource pool.

The chemical manufacturing plant at LaPlatte, Nebraska, is the other major self-supplied industrial user within the area. Anhydrous ammonia, ammonia nitrate, uran and urea compounds are the major products produced. Their chemical processes require large quantities of cooling water which is non-consumptively used.

Of the total 20 mgd usage, 19 mgd are used by cooling units. The total water requirement is supplied by a well field located along the Platte River. Raw water from the Platte River aquifer used for cooling requires a minimal degree of treatment. Water usage by other self-supplied industries within the study area is small with respect to the quantity of water withdrawn by the two major industries.

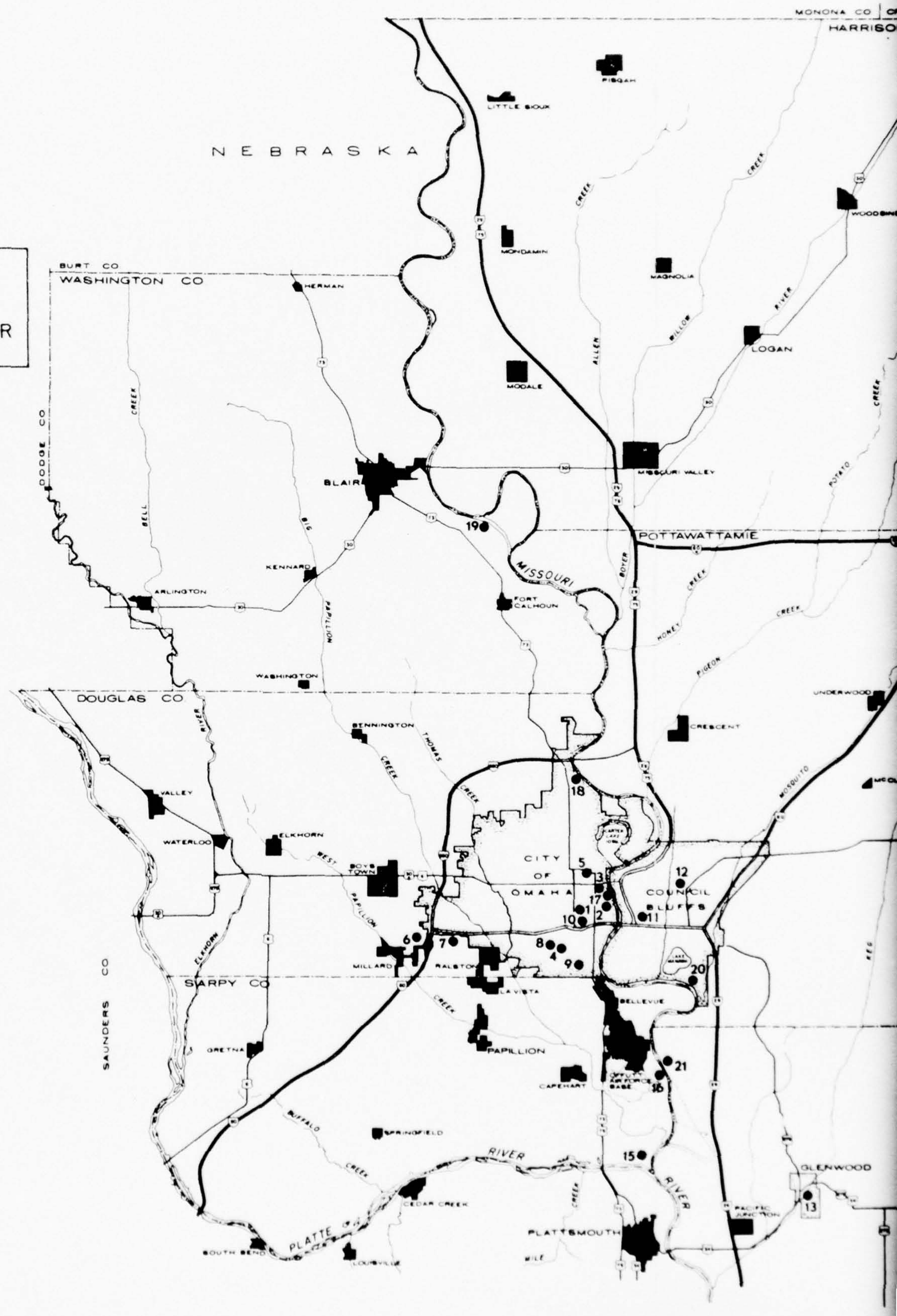
Self-supplied industrial users for which data are available use 1184 mgd of river water and 22 mgd of well water to meet their average day demands. The major municipal and self supplied industrial users are summarized in Table II-3 with locations shown on Figure II-4.

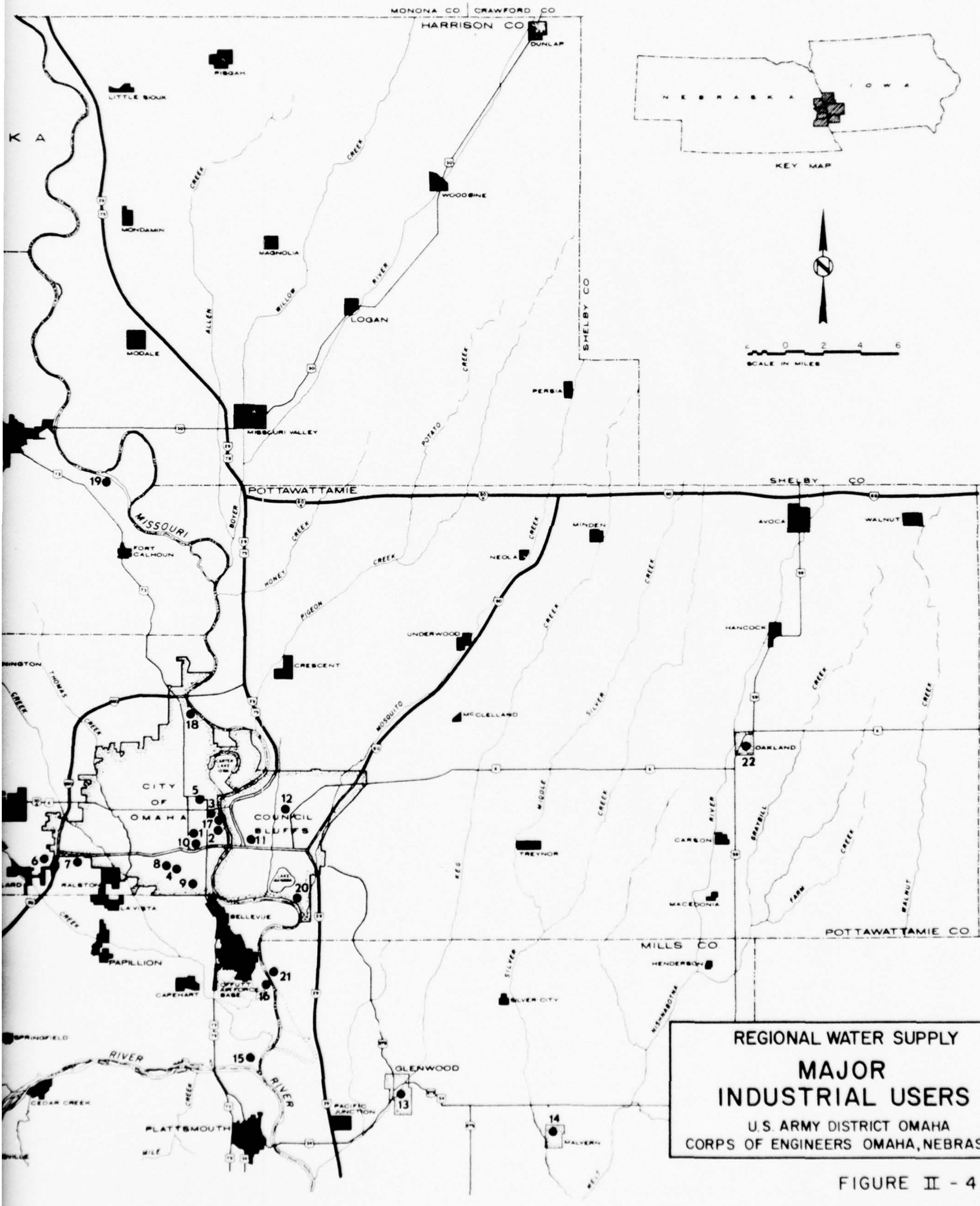
LEGEND

7 ● INDUSTRIAL IDENTIFICATION NUMBER

POWER PLANTS

16 KRAMER STATION
17 JONES STREET STATION
18 NORTH OMAHA STATION
19 FORT CALHOUN STATION
20 SOUTH COUNCIL BLUFFS STATION





REGIONAL WATER SUPPLY

MAJOR INDUSTRIAL USERS

U.S. ARMY DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE II - 4

2

TABLE II -3

MAJOR INDUSTRIAL USERS

I.D.NUMBER	LOCATION	SIC	PRODUCT DESCRIPTION	1973 AVERAGE DAILY WATER USE MGD
1	OMAHA	20	FOOD AND KINDRED PRODUCTS	2.162
2	OMAHA	28	CHEMICALS	7.200
3	OMAHA	20	FOOD AND KINDRED PRODUCTS	1.452
4	OMAHA	20	FOOD AND KINDRED PRODUCTS	1.156
5	OMAHA	40	TRANSPORTATION SERVICE	0.896
6	OMAHA	36	ELECTRICAL SUPPLIES AND EQUIPMENT	0.632
7	OMAHA	20	FOOD AND KINDRED PRODUCTS	0.606
8	OMAHA	20	FOOD AND KINDRED PRODUCTS	0.583
9	OMAHA	20	FOOD AND KINDRED PRODUCTS	0.519
10	OMAHA	20	FOOD AND KINDRED PRODUCTS	0.493
11	COUNCIL BLUFFS	20	FOOD AND KINDRED PRODUCTS	2.0
12	COUNCIL BLUFFS	20	FOOD AND KINDRED PRODUCTS	0.832
13	GLENWOOD, IOWA	20	FOOD AND KINDRED PRODUCTS	0.775
14	MALVERN, IOWA	20	FOOD AND KINDRED PRODUCTS	0.092
15	LA PLATTE, NEBRASKA	28	CHEMICALS	20.000
16	OMAHA	–	ELECTRIC POWER GENERATION	108.785
17	OMAHA	–	ELECTRIC POWER GENERATION	58.804
18	OMAHA	–	ELECTRIC POWER GENERATION	482.226
19	FORT CALHOUN	–	ELECTRIC POWER GENERATION	440.650
20	COUNCIL BLUFFS	–	ELECTRIC POWER GENERATION	91.070
21	COUNCIL BLUFFS	09	FISHERY	8.836
22	OAKLAND, IOWA	20	FOOD AND KINDRED PRODUCTS	1.674

Omaha-Council Bluffs Industrial Water Use

Industrial water quality requirements can be differentiated according to industrial type. The metro area exhibits six major industrial categories which include food and kindred products processing, chemical manufacturing, primary metal processing, metal fabrication, electrical manufacturing, and electric power generation.

The food and kindred products industry is the major industrial category with respect to the number of firms involved and in terms of employment and economic opportunity provided to the area. Approximately forty-three firms of significant size are involved in processing various types of food products for area and regional consumers. A substantial portion of the categories total water demand is consumed by the meat packing industry. Eight meat packing firms are among the ten largest water using industries in the metro area.

Water quality requirements for various water uses within the food processing industry are shown in Tables II-4 and II-5.

TABLE II-4

WATER QUALITY CRITERIA

(mg/l EXCEPT AS NOTED)

USE	TURBIDITY, UNITS	COLOR, UNITS	TASTE & ODOR	DISSOLVED SOLIDS	HARDNESS $CaCO_3$	ALKALINITY AS $CaCO_3$	pH, UNITS	Cl	SO_4	Fe	Mn	H_2S	Fl
BREWING	0-10	0-10	NONE	500-1500	-	80-150	6.5-7.0	60-100	-	.1-1.0	.1	.2	1.0
BOILER FEED				SEE TABLE II-5									
DAIRY	-	NONE	NONE	500	180	-	-	30	60	.1-.3	.03-.1	-	-
AIR CONDITIONING	-	-	LOW	-	-	-	-	-	-	.5	.5	-	-
FOOD PROCESSING GENERAL	1-10	5-10	LOW	850	10-250	30-250	-	-	-	.2	.2	-	1.0
FOOD EQUIPMENT WASHING	1.0	5-20	NONE	850	10	-	-	250	-	.1	.1	-	1.0
FOOD CANNING & FREEZING	1-10	-	NONE	850	50-85	30-250	7.5	250	-	.2	.2	1.0	1.0
CARBONATED BEVERAGES	1-2	5-10	NONE	850	200-250	50-128	-	250	250	.1-.2	.2	0-.2	.2-1.0
COOLING	50	-	-	-	50	-	-	-	-	.5	.5	-	-
CONFECTIONARY	-	-	LOW	-	-	-	7.0	-	-	.2	.2	.2	-
BAKING	10	10	NONE	-	-	-	-	-	-	0.2	0.2	0.2	-

Source: McKee and Wolf, Water Quality Criteria

TABLE II - 5
SUGGESTED LIMITS OF TOLERANCE FOR BOILER FEED WATERS

(From Progress Report of the Committee on Water Quality Tolerances for Industrial Uses, NEWWA) (159)

(units are in mg/l except as otherwise noted)

Pressure (psi)	*0-150*	*150-250*	*250-400*	*Over 400*
Turbidity	20	10	5	1
Color	80	40	5	2
Oxygen consumed	15	10	4	3
Dissolved oxygen**	2.0[a]	0.2[a]	0.0	0.0
Hydrogen sulfide *	5	3	0	0
Total hardness ($CaCO_3$)	80	40	10	2
Sulfate-carbonate ratio (ASME) (Na_2SO_4:Na_2CO_3)	1:1	2:1	3:1	3:1
Aluminum oxide	5	0.5	0.05	0.01
Silica	40	20	5	1
Bicarbonate **	50	30	5	0
Carbonate	200	100	40	20
Hydroxide	50	40	30	15
Total solids [b]	3000-500	2500-500	1500-100	50
pH value (Min.)	8.0	8.4	9.0	9.6

* Except when odor in live steam would be objectionable.
** Limits applicable only to feed water entering boiler, not to original water supply.
[a] Given as ml per liter. Multiply by 0.70 for ppm.
[b] Depends on design of boiler.

The chemical industry requires essentially two qualities of water, one of high quality for process and boiler make-up water and one of lesser quality for cooling units. Supplies of less than potable quality are usually adequate for cooling use, while process and boiler makeup water must be of at least potable quality and in some instances additional treatment may be required to obtain a quality suited to the process being used. Six major firms are currently involved in various chemical operations. The water quality requirements for this industry are illustrated in Table II-6.

TABLE II-6

WATER QUALITY REQUIREMENTS-CHEMICAL INDUSTRY

USE	TURBIDITY UNITS	DISSOLVED SOLIDS	HARDNESS	Cl	SO_4	Fe	Mn
BOILER FEED		SEE	TABLE	II-5			
PROCESS WATER	—	500	150	250	250	0.3	0.05
COOLING	50	—	50	—	—	0.5	0.5

(mg/l EXCEPT AS NOTED)

The primary metal industry localized in the metro area lists eleven firms employing some type of wet process in their operations. Of the total water draft required by the metal industry, a significant amount is utilized in cooling operations with lesser quantities being used for cleaning and rinsing. The metal fabricating industrial category includes twenty-five major firms which manufacture a miscellany of metal products and machinery. Water use within this category is similar to that of the primary metal industry with respect to water quality and use. Metal fabrication processes tend to require larger drafts of process waters than do metal processing operations. The water quality requirements for both industrial categories are outlined in Table II-7.

TABLE II-7

WATER QUALITY REQUIREMENTS-METAL'S INDUSTRY

USE	TURBIDITY UNITS	DISSOLVED SOLIDS	HARD-NESS	Cl	SO_4	Fe	Mn
PROCESS WATER	—	500	150	250	250	0.3	0.05
COOLING	50	—	50	—	—	0.5	0.5

(mg/l EXCEPT AS NOTED)

Electrical power generating facilities in the metro area exert the largest industrial water demand. This draft is almost exclusively used for cooling and returned directly to the Missouri River without significant volume reduction. Because of extremely large volume requirements, the four power plants along the Missouri River in the Omaha-Council Bluffs area are largely self-supplied with respect to their water needs. The cooling water is procured from the Missouri River with very small quantities of supplemental water being supplied from the MUD system and private wells. The following water quality requirements are suggested for such cooling water: the water should have an appropriate initial temperature and should not deposit scale, be corrosive, or encourage the growth of slimes. Among the constituents of natural water that may prove detrimental to its use for cooling purposes are hardness, suspended solids, dissolved gases, acids, oil and other organic compounds and slime-forming organisms.

In addition to the water quality requirements listed for the various water uses within each industrial category, a water

of potable quality, meeting U. S. Public Health Standards, should be available for drinking and domestic purposes.

With the exclusion of power plants, the bulk of the metropolitan area's industrial demand is supplied by the MUD and Council Bluffs municipal systems.

Non-Metropolitan Area Industrial Water Demand

The non-metropolitan area exhibits the same general types of industry as found in the metropolitan area. Food and kindred products processing, chemical manufacturing, primary metal processing, metal fabrication, electrical manufacturing, and electric power generating applications in addition to sand and gravel operations are found in the non-metropolitan area.

Sand and gravel operations use large quantities of non-potable quality water for dredging and washing purposes. The other industrial categories exhibit water quality needs similar to those outlined in the metro area industrial water use section.

Agricultural

Agricultural Crop Irrigation. Water usage for crop irrigation is projected from permits for surface water diversion and irrigation well capacity. Total acres irrigated and probable average year usages were available for the Iowa counties while only irrigated acreage was available for the Nebraska counties. A probable average year usage of one acre-foot per irrigated acre was estimated for the Nebraska counties. Thus the crop irrigation usages shown in Tables II-17 through II-24 are probable average year usages rather than 1973 figures. Actual yearly usage is dependent upon rainfall and temperature variations and is not directly determined for all irrigated acres.

Locations of irrigation wells are shown on Figure II-1. Use of groundwater for crop irrigation is heaviest at the confluence of the Platte and Elkhorn Rivers in Douglas County, Nebraska. Diversion or impoundment of surface water for irrigation is scattered throughout the area.

The following table summarizes irrigated acreage and average year use for 1973.

TABLE II-8

1973 STUDY AREA CROP IRRIGATION

Source	Irrigated Acres	Average Usage
Iowa Counties		
Ground Water	19,900 Acres	20,800 AFY
Surface Water	2,300 Acres	2,500 AFY
Total Water	22,200 Acres	23,300 AFY
Nebraska Counties		
Ground Water	20,200 Acres	20,200 AFY
Surface Water	3,600 Acres	3,600 AFY
Total Water	23,800 Acres	23,800 AFY
Total Study Area	46,000 Acres	47,100 AFY

Source: Registration lists from the State of Nebraska, Department of Water Resources and the Iowa Natural Resources Council.

Salinity is of primary concern when evaluating water quality for crop irrigation. In general, as the salinity of irrigation water increases, crop yield decreases. Common field and forage crops grown in the study area are listed hereafter from

least tolerant to most tolerant with respect to salinity: Corn, alfalfa, soybean, sorghum and wheat. Essentially all natural surface and ground waters in the study area are of suitable quality for crop irrigation.

TABLE II-9

QUALITY GUIDELINES FOR IRRIGATION WATER

Quality Factor	Threshold Concentration[1]	Limiting Concentration[2]
Coliform organisms, MPN per 100 ml	1000[3]	-[4]
Total dissolved solids (TDS) mg/liter	500[3]	1500[3]
Electrical conductivity, mmhos/cm	750[3]	2250[3]
Range of pH	7.0-8.5	6.0-9.0
Sodium absorption ratio (SAR)	6.0[3]	15
Residual sodium carbonate (RSC), meq.	1.25[3]	2.5
Arsenic, mg/liter	1.0	5.0
Boron, mg/liter	0.5[3]	2.0
Chloride, mg/liter	100[3]	350
Sulfate, mg/liter	200[3]	1000
Copper, mg/liter	0.1[3]	1.0

(continued next page)

[1]Threshold values at which irrigator might become concerned about water quality.

[2]Limiting values at which the yield of high-value crops might be reduced drastically or at which an irrigator might be forced to less valuable crops.

[3]Values not to be exceeded more than 20 percent of any 20 consecutive samples, nor in any 3 consecutive samples. The frequency of sampling should be specified.

[4]Aside from fruits and vegetables which are likely to be eaten raw, no limits can be specified. For such crops, the threshold concentration would be limiting.

Source: McKee and Wolf, Report to the California State Water Quality Control Board.

TABLE II-10

GUIDELINES FOR SALINITY IN IRRIGATION WATER FOR ARID REGIONS

Crop Response	TDS, mg/l	Conductivity umhos/cm
Water for which no detrimental effects will usually be noticed	500	0.75
Water which can have detrimental effects on sensitive crops	500-1,000	0.75-1.50
Water that may have adverse effects on many crops and requiring careful management practices	1,000-2,000	1.50-3.00
Water that can be used for salt-tolerant plants on permeable soils with careful management practices	2,000-5,000	3.00-7.50

Source: Federal Water Pollution Control Administration, Report of the Committee on Water Quality Criteria

TABLE II-11

TRACE ELEMENT TOLERANCES FOR IRRIGATION WATER

Element	For water used continuously on all soils mg/l	For short-term use on fine textured soils only mg/l
Aluminum	1.0	20.0
Arsenic	1.0	10.0
Beryllium	0.5	1.0
Boron	0.75	2.0
Cadmium	0.005	0.05
Chromium	5.0	20.0
Cobalt	0.2	10.0
Copper	0.2	5.0
Fluorine	1/	1/
Iron	1/	1/
Lead	5.0	20.0
Lithium	5.0	5.0
Manganese	2.0	20.0
Molybdenum	0.005	0.05
Nickel	0.5	2.0
Selenium	0.05	0.05
Tin	1/	1/
Tungsten	1/	1/
Vanadium	10.0	10.0
Zinc	5.0	10.0

1/ Poorly defined, discussed in source

Source: Federal Water Pollution Control Administration, Report of the Committee on Water Quality Criteria

Tables II-9, II-10, and II-11 give quality guidelines for irrigation water from two sources. The sodium-adsorption ratio (SAR) factor listed in Table II-9 is defined as:

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

where Na, Ca, and Mg are respectively the sodium, calcium, and magnesium ion concentrations.

Livestock Watering. Usages for livestock watering were not available for the entire seven county area. Usages listed in Tables II-17 through II-24 are based on the number of animals on feed and the following per animal usage:

	gpd/animal
Cattle	12
Hogs	5
Sheep	3
Poultry	0.1

Wells registered as supplying feedlots are shown on Figure 1.

Water quality factors affecting use by livestock are essentially the same as those affecting human consumption although most livestock are more tolerant of poorer quality water than humans. Table II-12 lists livestock watering guidelines.

TABLE II-12

QUALITY GUIDELINES FOR LIVESTOCK WATERING

Quality Factor	Threshold Concentration[1]	Limiting Concentration[2]
Total dissolved solids (TDS), mg/liter	2500	5000
Cadmium, mg/liter	5	
Calcium, mg/liter	500	1000
Magnesium, mg/liter	250	500[3]
Sodium, mg/liter	1000	2000[3]
Arsenic, mg/liter	1	
Bicarbonate, mg/liter	500	500
Chloride, mg/liter	1500	3000
Fluoride, mg/liter	1	6
Nitrate, mg/liter	200	400
Nitrite, mg/liter	None	None
Sulfate, mg/liter	500	1000[3]
Range of pH	6.0 - 8.5	5.6 - 9.0

[1] Threshold values represent concentrations of which poultry or sensitive animals might show slight effects from prolonged use of such water. Lower concentrations are of little or no concern.

[2] Limiting concentrations based on interim criteria, South Africa. Animals in lactation or production might show definite adverse reactions.

[3] Total magnesium compounds plus sodium sulfate should not exceed 50 percent of the total dissolved solids.

Source: McKee and Wolf, Report to the California State Water Quality Control Board

Recreational

Although recreational usage is listed as one of the user categories, no quantities are listed. Water related recreational facility information will be available from Bureau of Outdoor Recreation studies. It is doubtful that significant amounts of water are actually consumed or made unsuitable for other beneficial use by actual recreational usage. Use of streams, lakes or other bodies of water in their state for recreational purposes has little effect upon other water users. Diversion and/or impoundment of water for recreational or multipurpose uses affects the areas and periods of water availability for other uses more than decreasing the quantity or quality. Therefore it is difficult, if not impossible, to associate a quantity with recreational water usage which corresponds with the quantities consumed or used by the other users.

The information available on water related recreational facilities are summarized by counties. High use rates at existing facilities, particularly in the metropolitan area,

indicate a severe shortage of water related recreational areas that are available to the citizenry.

A desire to make use of the limited recreational waters of the area has created a potential health hazard, particularly along the Platte and Elkhorn Rivers. Developments featuring recreation oriented first and second houses frequent the river valleys especially around lakes created by sand and gravel dredging operations. Individual dwelling water supply and waste disposal systems, while meeting existing regulatory agency design requirements, may be inadequate to insure prevention of water supply contamination.

Minimum design standards such as the 150 foot well-sewage disposal system separation and up-slope well location required by the Nebraska State Health Department are usually adequate for isolated dwellings. Several factors present in existing and planned developments tend to negate the effectiveness of generalized design requirements. Soil types allowing direct and rapid percolation of waste water into ground water, high water table, relatively small lot size, and inadequate attention to construction and operation details are conditions often present in study area

developments which encourage ground water contamination.

Stricter attention to design and construction details and centralized water supply and/or sewage treatment are possible solutions to the recreational development health hazard in the study area. Desire for a high quality, safe water supply together with provisions of the 1974 Safe Drinking Water Act should encourage centralization of water supply and distribution systems alleviating potential health problems. Sewage collection and disposal methods minimizing potential ground water contamination should also be considered.

Water quality requirements for recreational use is divided into two general categories; water used in full body contact sports such as swimming, water skiing, and skin diving, and water used in partial body contact sports such as boating and for the growth and propagation of fish, waterfowl and other wildlife.

Criteria for water body contact sports are generally more restrictive than those for non-body contact recreation. Water quality criteria, relative to recreation, are outlined in the following exhibits of Nebraska and Iowa Surface Water Standards.

TABLE II-13

NEBRASKA WATER QUALITY CRITERIA

Applicable to Category 1 Waters

Wastewater discharge shall not degrade the receiving waters below the following criteria.

These criteria are applicable to impoundments described in water use classification A and to perennial flowing waters with a seven consecutive day, one in 10 year low flow greater than 0.1 cfs and for design purposes, are applicable at flows equal to or greater than the lowest flow for seven consecutive days, which can be expected to occur at a frequency of once every ten years.

CLASS "A"

Full Body Contact Sports, Domestic Water Supply, Fish, Wildlife, and other Aquatic and Semiaquatic Life

	Parameter	Criteria
1.	Fecal Coliform Organisms	Fecal coliform organisms shall not exceed a geometric mean of 200 per 100 milliliters, nor equal or exceed 400 per 100 milliliters in more than 10 percent of the samples.
2.	Taste & Odor Producing Substances	Concentrations of substances shall be less than the amount which would degrade the water quality for the designated uses. Phenols concentrations shall not exceed 0.001 mg/l.
3.	Suspended, Colloidal, or Settleable Solids	None from wastewater sources which will permit objectionable deposition or be deleterious for the designated uses. In no case shall turbidity caused by wastewater impart more than a 10 percent increase in turbidity to the receiving water.
4.	Toxic and Deleterious Substances	None alone or in combination with other substances or wastes in concentrations of such nature so as to render the receiving water unsafe or unsuitable for the designated uses. Ammonia nitrogen concentrations shall not exceed 1.4 mg/l in trout waters nor exceed 3.5 mg/l in warm waters where the pH in these waters does not exceed a pH value of 8.3. If the pH value of a water exceeds 8.2, the maximum allowable

TABLE II-13 (cont'd)

		limits of ammonia expressed as nitrogen shall be in accordance with Table 11 in the standards. Radiological limits shall be in accordance with the Radiological Health Regulations, State of Nebraska, First Edition 1966, as amended. Discharge of radiological, chemical, or biological warfare agents are prohibited.
5.	Temperature (Ice-free Conditions)	The temperature of the receiving water shall not be increased by a total of more than 5° F from natural. Maximum rate of change limited to 2° F per hour. For Missouri River from South Dakota-Nebraska state line near Ft. Randall Dam to Sioux City, Iowa, maximum temperature limit is 85° F with an allowable change of 4° F from natural. For trout waters, the maximum limit is 65° F with an allowable change of 5° F from natural. For warm waters the maximum limit is 90° F. For impoundments, the temperature of the epilimnion or surface water shall not be raised more than 3° F above that which existed before the addition of heat of artificial origin. Unless a special study shows that the discharge of heated effluent into the hypolimnion will be desirable, such practice is not recommended and water for cooling shall not be pumped from the hypolimnion to be discharged to the same body of water.

TABLE II-13 (Cont'd)

6.	Dissolved Oxygen	Shall not be lower than 5 mg/l in warm waters and 6 mg/l in trout waters.
7.	Hydrogen Ion	Hydrogen ion concentrations expressed as pH shall be maintained between 6.5 and 8.5 with a maximum total change of 0.5 pH unit from the value in the receiving waters.
8.	Total Dissolved Solids	A point source discharge shall not increase the total dissolved solids (TDS) concentration of the receiving water by more than 10 percent and in no case shall the total dissolved solids of a stream exceed 600 mg/l. Data regarding specific conductance will be considered in lieu of TDS data. A point source discharge shall not increase the conductivity of the receiving water by more than 10 percent and in no case shall the conductivity exceed 900 micromhos per centimeter at 25° C.
9.	Residue, Oil, and Floating substances	No residue attributable to wastewater or visible film of oil or globules of grease shall be present. Emulsified oil and grease shall be less than 10 mg/l.
10.	Aesthetic Conditions	No evidence of matter that creates nuisance conditions or is offensive to the senses of sight, touch, smell, or taste, including color.

CLASS "B"

Partial Body Contact Sports, Agricultural, Industrial, Fish, Wildlife and other Aquatic and Semi-aquatic Life

TABLE II-13 (Cont'd)

Parameter		Criteria
1.	Fecal Coliform Organisms	Fecal coliform organisms shall not exceed a geometric mean of 1,000 per 100 milliliters, nor equal or exceed 2,000 per 100 milliliters in more than 10 percent of the samples.
2.	Taste & Odor Substances Producing	Same as Class "A" plus shall not contain concentrations of substances which will render any undesirable taste to fish flesh, or in any other way make such fish flesh inedible.
3.	Suspended, Colloidal, Solids or Settleable	Same as Class "A"
4.	Toxic and Deleterious substances	Same as Class "A" plus for irrigation use, the boron concentration shall not exceed 0.75 mg/l. Toxic materials not specified shall be determined by the Department as specified on page 1 of the standards.
5.	Temperature	Same as Class "A"
6.	Dissolved oxygen	Same as Class "A"
7.	Hydrogen Ion	Hydrogen ion concentrations expressed as pH shall be maintained between 6.5 and 9.0 with a maximum total change of 0.5 pH unit from the value in the receiving waters.
8.	Total Dissolved Solids	A point source discharge shall not increase the TDS of the receiving stream by more than 20 percent, this value shall not exceed 100 mg/l, and in no case shall the TDS of a water exceed 1500 mg/l.

TABLE II - 13 (Cont'd)

		Specific conductance may be considered in lieu of TDS data. A point source discharge shall not increase the conductivity by more than 20%, this value shall not exceed 150 micromhos/cm, and in no case shall the conductivity of a water exceed 2250 micromhos/cm at 25° C. For irrigation use, the SAR value and conductivity shall not be greater than a C3-S2 Class irrigation water as shown in Fig. 25 of Ag. Handbook 60.
9.	Residue, Oil & Floating Substances	Same as Class "A"
10.	Aesthetic conditions	Same as Class "A"

TABLE II-14

IOWA WATER QUALITY CRITERIA

16.3 (455B) Surface Water Quality Criteria

16.3(1) General Water Quality Criteria. The following criteria are applicable to all surface waters including those which have been designated as Class A, B, or C Waters at all places and at all times.

(a) Such waters shall be free from substances attributable to municipal, industrial or other discharges or agricultural practices that will settle to form objectionable sludge deposits.

(b) Such waters shall be free from floating debris, oil, grease, scum and other floating materials attributable to municipal, industrial or other discharges or agricultural practices in amounts sufficient to be unsightly or deleterious.

(c) Such waters shall be free from materials attributable to municipal, industrial or other discharges or agricultural practices producing color, odor or other conditions in such degree as to create a nuisance.

(d) Such waters shall be free from substances attributable to municipal, industrial or other discharges or agricultural practices in concentrations or combinations which are toxic or harmful to human, animal, plant or aquatic life.

(e) The turbidity of the receiving water shall not be increased by more than 25 Jackson turbidity units by any point source discharge.

16.3(2) Class A Waters. Waters which are designated as Class A Waters are to be protected for primary contact recreation. The following criteria shall apply to all Class A Waters:

(a) From April 1 through October 31 the discharge of any effluent which may contain human pathogens shall not increase the fecal coliforms in the receiving waters by more than 200 per 100 ml.

(b) The pH shall not be less than 6.5 nor greater than 9.0. The maximum change permitted as a result of a waste discharge shall not exceed 0.5 pH units.

(c) Taste and odor producing substances shall not be present in amounts that will interfere with primary contact recreation.

16.3.(3) <u>Class B Waters.</u> Waters which are designated as Class B Waters are to be protected for wildlife, fish, aquatic and semi-aquatic life and secondary contact recreation. The following criteria shall apply to all Class B Waters:

(a) Dissolved Oxygen:

1. The dissolved oxygen shall not be less than 5.0 mg/l during at least 16 hours of any 24 hour period and not less than 4.0 mg/l at any time during the 24 hour period.

2. In areas designated as cold water fisheries the dissolved oxygen shall not be less than 7.0 mg/l during at least 16 hours of any 24 hour period and not less than 5.0 mg/l at any time during the 24 hour period.

(b) Chemical Constituents:

The following levels shall not be exceeded at any time the flow equals or exceeds the seven day-ten year low flow unless the material is from uncontrollable non-point sources:

Ammonia Nitrogen (N)	2.0	mg/l
Phenols (other than natural sources)	0.001	mg/l
Arsenic	1.0	mg/l
*Barium	1.0	mg/l
*Cadmium	0.05	mg/l
*Chromium (hexavalent)	0.05	mg/l
*Chromium (trivalent)	1.0	mg/l
*Copper	0.02	mg/l
Cyanide	0.025	mg/l
*Lead	0.10	mg/l
*Zinc	1.0	mg/l
*Selenium	1.0	mg/l
*Mercury	.005	mg/l
TDS	750.00	mg/l

*The sum of the entire heavy metal group shall not exceed 1.5 mg/l.

(c) All substances toxic or detrimental to aquatic life shall be limited to non-toxic or non-detrimental concentrations in the surface water.

(d) The fecal coliform content shall not exceed 2,000 organisms per 100 ml, except when the waters are materially affected by surface runoff.

(e) The pH shall be not less than 6.5 nor greater than 9.0. The maximum change permitted as a result of a waste discharge shall not exceed 0.5 pH units.

(f) Temperature

1. No heat shall be added to interior streams that would cause an increase of more than 5° F. The rate of temperature change shall not exceed 2° F per hour. In no case shall heat be added in excess of that amount that would raise the stream temperature above 90° F.

2. No heat shall be added to streams designated as cold water fisheries that would cause an increase of more than 3° F. The rate of temperature change shall not exceed 2° F. per hour. In no case shall heat be added in excess of that amount that would raise the stream temperature above 68° F.

3. No heat shall be added to lakes and reservoirs that would cause an increase of more than 3° F. The rate of temperature change shall not exceed 2° F per hour. In no case shall heat be added in excess of that amount that would raise the temperature of the lake or reservoirs above 90° F.

4. No heat shall be added to the Missouri River that would cause an increase of more than 5° F. The rate of

temperature change shall not exceed 2° F per hour. In no case shall heat be added that would raise the stream temperature above 90° F.

5. No heat shall be added to the Mississippi River that would cause an increase of more than 5° F. The rate of temperature change shall not exceed 2° F per hour. In addition, the water temperature at representative locations in the Mississippi River shall not exceed the maximum limits in the below table during more than one percent of the hours in the 12 month period ending with any month. Moreover, at no time shall the water temperature at such locations exceed the maximum limits in the below table by more than 3° F.

Zone II	Iowa-Minnesota State line to the Northern Illinois border (Mile Point 1534.6)
Zone III	Northern Illinois border (Mile Point 1534.6) to Iowa-Missouri State line

Month	Zone II	Zone III
January	40° F	45° F
February	40° F	45° F
March	54° F	57° F
April	65° F	68° F
May	75° F	78° F
June	84° F	85° F
July	84° F	86° F
August	84° F	86° F
September	82° F	85° F
October	73° F	75° F
November	58° F	65° F
December	4[illegible] F	52° F

(g) The waters shall contain no substances which will impart any undesirable tastes to fish flesh, or in any other way make fish unedible.

WATER SUPPLY SYSTEMS

Water supply systems in the study area are of three types: municipal, private and rural water district. At present, there is only one rural water district in operation, that being in Cass County, Nebraska. Districts serving a majority of the farmsteads

and some of the rural communities have been proposed for all counties except Douglas and Sarpy in Nebraska which are highly urbanized.

There are 55 municipal systems in the study area, the largest of which is the Omaha Metropolitan Utilities District which served 69 percent of the population and 77 percent of the demand in 1973. An inventory of municipal water systems containing detailed information for each individual system is contained in this report as Appendix A. The municipally supplied communities are shown on Figure II-1 along with 1973 average day demands.

Private supplies of an undetermined number are located throughout the study area and range in size and purpose from single family residential wells to industrial cooling water systems withdrawing millions of gallons per day from wells or rivers. Private residential supplies account for less than 3 percent of the 1973 water supply. A majority of these systems are expected to be eliminated or relegated to a standby or alternative nonpotable source status upon implementation of planned Rural Water Districts. Following are summaries by county of the existing water supply systems in the study area including future needs as determined by other studies.

Nebraska

Cass County. Cass County, Nebraska has one first class city (Plattsmouth), two second class cities, eleven villages and four unincorporated communities. All of the incorporated areas are served by municipal water systems employing well sources with the exception of Manley and South Bend. Rural residents, the residents of South Bend and Manley, and the unincorporated communities utilize private well systems.

Industrial water usage in the county is minimal with no major self-supplied or municipally-supplied industries, except for feedlots having private wells. About 2500 acres of agricultural croplands were irrigated in 1973. Approximately 40% of the total acreage was irrigated by surface water diversions from Salt, Branch, Weeping Water, Cedar, Turkey and Four-mile Creeks and from the Missouri River. The remaining irrigated acres are concentrated along Salt Creek and irrigated from wells.

Major residential recreational developments include Beaver Lake, Buccaneer Bay (planning stage), Cedar Creek Lakes, Lake Waconda, and the Eagle Lake subdivision. The Louisville State Sand Pit Lakes, Missouri River, and the Platte River provide additional water related recreational opportunities within the county.

All municipal water supply and distribution systems are owned and operated by respective city or village governments. Of the cities for which water-rate pricing data were available, only one (Weeping Water) had a flat rate schedule while all other municipalities had a declining unit price billing with the lowest rate being in a range of 20 to 54¢ per 1000 gallons.

The Plattsmouth and Nehawka municipal systems are the only water supplies in the county which furnish water treatment or disinfection. Iron and manganese removal, softening and disinfection are provided at Plattsmouth and Nehawka water treatment plants. No water treatment is provided by the other municipalities prior to distribution. The untreated raw water supplies characteristically have high dissolved solids, iron, or manganese concentrations. The standard of quality is somewhat higher along the Platte and Missouri Rivers than in the rest of the county. Water supplied to the residents of Eagle, Alvo, Murdock, Elmwood, Weeping Water, Avoca, Union, and Murray exceed suggested Public Health Service drinking water standards for iron and/or manganese. Adequate sources of potentially fair quality ground water exist along the Platte and Missouri Rivers. The availability and quality of ground water diminishes in the rest of the county. Season water shortages are prevalent and in some instances local

farmers must haul water from nearby communities to meet their demands.

A comprehensive plan for developing and implementing Rural Water Districts is currently being prepared by Bartlett and West, Consulting Engineers, of Topeka, Kansas. The plan involves the development of three rural water districts. Rural Water District No. 1 (RWD 1) is in the implementation stage and will serve the Village of Murray and rural residents in the eastern sector of the county. This district currently purchases water from the Plattsmouth Municipal System. A proposed district (RWD 2) in the southwestern portion of the county would serve rural users with bulk purchases of water from Otoe County RWD 3. An expansion of Otoe County RWD 3 will serve the Villages of Avoca and Manley, in addition to serving rural residents of central Cass County when completed. Otoe County RWD 3 will utilize a groundwater supply southeast of Burr, Nebraska in the Nemaha Valley as its water supply source. The Plattsmouth system currently employes a groundwater supply. Force main and storage improvements have recently been constructed at Plattsmouth, Nebraska. Municipalities not supplied from rural water districts will be required to expand their distribution systems and provide

treatment as dictated by future demands.

Available data does not indicate any reuse or recycling of water or wastewater in Cass County.

Current and future water usages are shown in the tables at the end of this section. Plattsmouth is a satellite city under urban growth concept B and will have water usages varying from those listed under this concept.

Douglas County, Nebraska has one metropolitan city (Omaha), three second class cities, and two villages. Omaha and Ralston are served by the Omaha Metropolitan Utilities District. The other communities are served by municipal systems with well supplies. Rural residences not in the metro area are served by private water supplies, primarily wells.

The greater portion of the total seven county industrial water use is concentrated in Omaha and supplied by MUD. Major self-supplied industrial users in the county include two electric power generation facilities using Missouri River water for cooling purposes, a manufacturing plant using a private well supply, and feed lots utilizing private wells or impoundments. About 9800 acres

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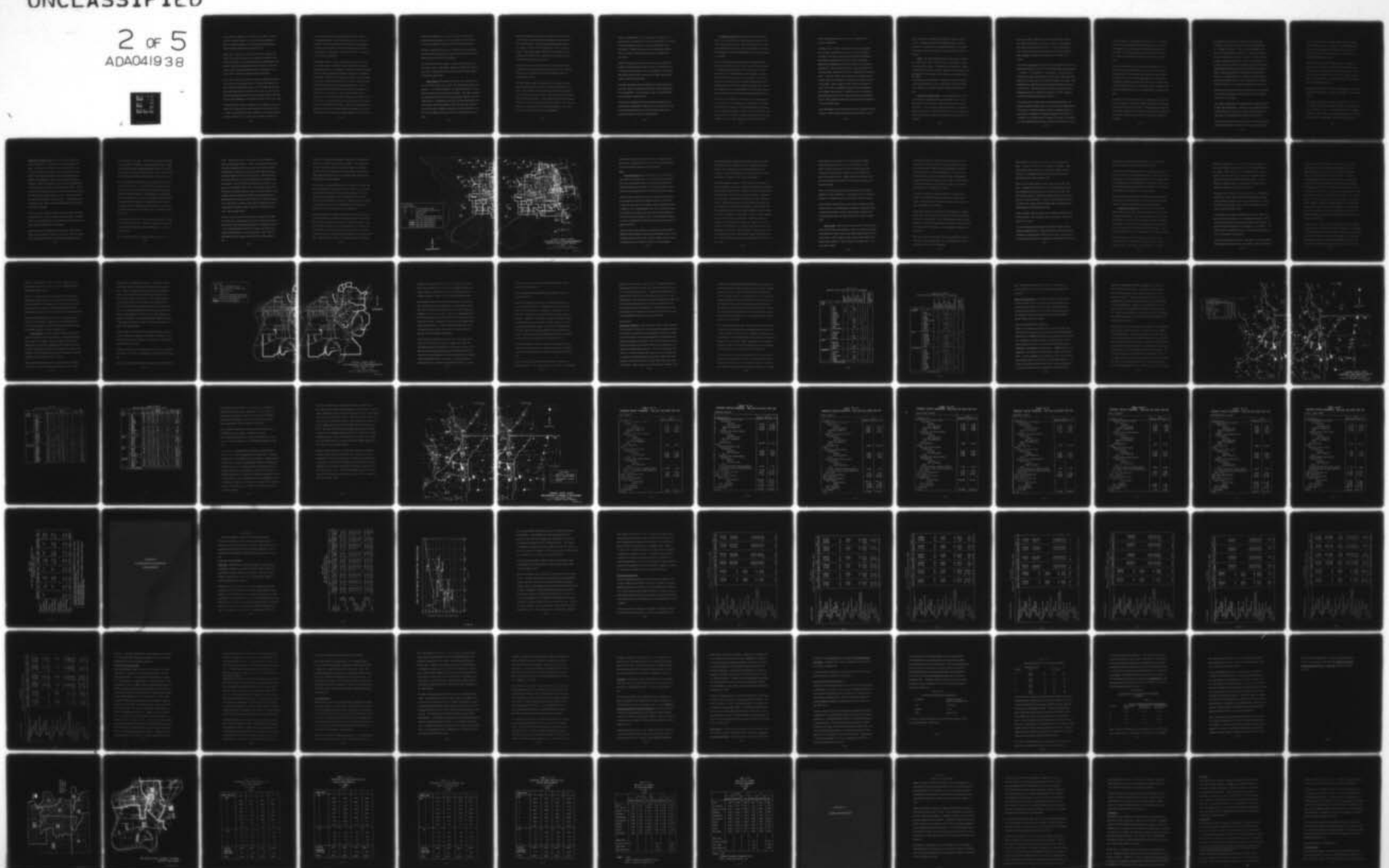

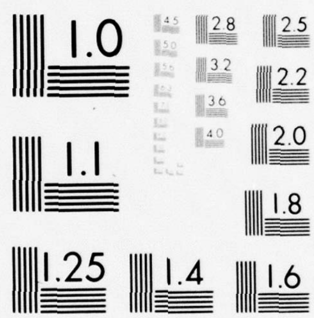

MICROCOPY RESOLUTION TEST CHART
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of agricultural croplands in the county are irrigated. Nearly all of the irrigated land lies between the Platte and Elkhorn Rivers in western Douglas County with more than 90 percent of the irrigation water being supplied by wells.

Kings Lake, Ginger Cove, and Riverside Lakes comprise the larger recreational/residential developments within the county. Similarly, smaller recreational/residential developments can be found at other sand pits and small lakes in the area. The additional growth of such developments can be anticipated as a result of lakes created from sand and gravel operations.

Major water related recreational facilities in Douglas County include Two Rivers Recreation Area, a "Put and take fishery" between the Platte and Elkhorn Rivers, N. P. Dodge Park containing a man-made lake and a Missouri River access, and Levi Carter Park containing an oxbow lake and boating facilities. Thirteen of the proposed Papillion Creek Reservoirs are to be in the county.

The MUD system, which is summarized in a separate section, furnishes over 98 percent of the municipal water used in the county. All other municipal water supply systems are owned and operated by their respective city or village governments. Ralston owns

their system, but water is purchased from and the system is managed by MUD. Boys Town and Carter Lake are served by MUD. Of the communities for which water-rate pricing information was available, all had declining unit pricing with increasing water consumption. The lowest rate was in a range of 20 to 30¢ per 1000 gallons.

Bennington, Elkhorn, Valley, and Waterloo pump raw well water, which exceeds United States Public Health service recommended limits for iron, manganese, and/or total dissolved solids, directly to their distribution systems without prior treatment or disinfection. MUD provides extensive treatment and disinfection of raw water from the Platte River well field and Missouri River before distribution to the metropolitan Omaha area. The untreated ground water quality characteristically has high concentrations of iron, manganese, and/or total dissolved solids. Ground water from along the Platte, Elkhorn, and Missouri Rivers has a lower concentration of dissolved solids than does the water from the central part of the county. Aquifers with adequate yield potential can be found along the Platte and Elkhorn Rivers in the western part of the county and along the Missouri River in the east.

Based upon existing data the small municipal systems do not possess standby pumping or power capabilities. No recycling or reuse of wastewater has been identified in Douglas County.

Kirkham, Michael and Associates of Omaha have recommended the construction of an elevated storage tank, distribution system extensions and a new well at Bennington.

Current and future water usages are shown in the tables at the end of this section. Bennington, Elkhorn and Valley are satellite cities under urban growth concept B and will have water usages varying from those listed.

Sarpy County, Nebraska has one first class city (Bellevue), six second class cities, one village, and eight unincorporated communities. La Vista and Capehart are supplied with water from the Omaha Metropolitan Utilities District (MUD). The other incorporated communities are served by municipal water systems with well supply sources. Papillion and Bellevue purchase additional water from MUD to meet peak demands. The unincorporated communities of Fort Crook, LaPlatte, Meadow, Portal and Richfield, and the rural residents are primarily served from private well supplies.

Major self-supplied industrial users in the county include one electric power generating facility using Missouri River water for cooling purposes, a chemical manufacturing plant with a well supply, and feed lots utilizing private wells or impoundments. Municipally supplied industry is concentrated in the northeastern portion of the county, and is provided with water from the MUD and Bellevue systems.

The major water related recreational facility in Sarpy County is Haworth Park located along the Missouri River near Bellevue. The Missouri and Platte Rivers provide additional water recreation opportunities.

The MUD system, which is summarized in a separate section, supplies approximately 70% of the counties municipal water demand. The remainder of this demand is provided by municipally owned and operated supply systems, with the exception of LaVista which is operated by MUD. Of the municipal supply systems from which water rate pricing information was available, all had declining unit price schedules for increased consumption. The lowest rate was in a range of 45 to 50¢ per 1000 gallons.

Gretna and Springfield do not provide water treatment or disinfection prior to distribution. Bellevue and Offutt A. F. B. provide iron and manganese removal, softening, disinfection, and fluoridation. MUD provides extensive treatment and disinfection of raw water from the Missouri River and Platte River well fields.

Aquifers along the Platte and Missouri Rivers are potentially capable of yielding large quantities of water. The ground water is characteristically high in iron and manganese in the central and eastern portion of the county and of a higher quality from aquifers along the Platte River.

Available information indicates that none of the municipal systems now owned or operated by MUD have standby pumping or power capabilities. No recycling or reuse of wastewater has been identified in Sarpy County.

Future plans designed to meet the county's growing water demands involve extensions of MUD service into urbanized areas in north Sarpy County and the continued improvement of the municipal systems in Gretna and Springfield.

Washington County, Nebraska has one first class city (Blair), four villages and one unincorporated community. All of the incorporated areas are served by municipal water systems employing well supplies. The unincorporated community of Washington and the rural population are served from private well supplies.

The Fort Calhoun power plant and cattle feeding operations are the major industrial users in the county. The power plant is supplied from the Missouri River and the feedlots utilize private wells or impoundments for their demands. Approximately 3900 agricultural acres were irrigated in 1973. Surface water diversions from the Elkhorn and Missouri Rivers provide water for 30% of the irrigated croplands. The remaining irrigated acres are concentrated in the northeastern sector of the county and watered from wells along the Missouri River.

The Missouri and Elkhorn Rivers provide recreational opportunity for water sport enthusiasts. All municipal water supply and distribution systems are owned and operated by respective city or village governments. Of the cities for which water-rate pricing data were available, Kennard and Herman have flat rate schedules while all other municipalities had a declining unit

price billing with the lowest rate being in a range of 15 to 30¢ per 1000 gallons.

Arlington, Blair, and Fort Calhoun provide iron and manganese removal, and disinfection of their raw water supplies. In addition, the Blair treatment plant also provides softening and Herman chlorinates its raw water before distribution. Kennard and Washington do not have disinfection or treatment capabilities. The untreated raw water supplies characteristically have high concentrations of iron, manganese and dissolved solids. Dissolved solids concentrations are somewhat lower along the Missouri and Elkhorn rivers than in the central portion of the county. Water supplied to the residents at Kennard exceeds U. S. P. H S. recommended limits for iron, manganese, and is high in total hardness. Adequate sources of potentially fair quality ground water exist along the Missouri and Elkhorn Rivers. The availability and quality of ground water diminishes in the rest of the county.

In the Washington County Comprehensive Water and Sewer Study, Kirkham, Michael and Associates proposed that future county

water needs be met through the formation of eight rural water districts. Supplying portions of Washington County, particularly the Ft. Calhoun area, from the MUD system is currently being studied under the auspices of the Papio Natural Resources District.

MUD. The Omaha Metropolitan Utilities District supplies by far the largest area, number of users, and quantity of water of any municipal system. In addition to serving Omaha, and the communities of Irvington, Ralston, Millard, LaVista, Boys Town and Capehart, MUD supplies part of Bellevue and Papillion's water needs.

The existing water system has a supply and treatment capacity of 200 million gallons per day. The Florence Plant and Platte River Plant have respective nominal capacities of 140 and 60 mgd.

Florence Treatment Plant. The existing Florence Treatment Plant was originally placed in operation in 1889, was expanded upon in 1923 and later expanded and modernized in the mid-fifties. It has a nominal capacity of 140 mgd. Treatment plant units with the exception of the filters are not enclosed, and winter icing problems have been encountered in the operation of the plant.

Raw water supply is obtained from the Missouri River through two reinforced concrete river intake structures, each equipped with trash racks and traveling screens. Under current operation, with a process water requirement of 25 percent of treated water pumpage, an intake raw water flow of 175 mgd is required.

Low service pumping facilities take water by suction from the river intakes and pump raw water to the presedimentation basins through 3 - 36-inch, 1 - 42-inch and 1 - 54-inch lines. The low service pumps have a total installed capacity of 190 mgd, a maximum firm capacity of 167 mgd, and a total electric capacity of 176 mgd. The maximum firm capacity has been determined with the large pump out of service. The present intake structures, and low service pumping facilities are adequate to supply a raw water supply for the present 140 mgd nominal plant capacity.

The present plant includes three presedimentation basins. The primary purpose of these basins is to remove heavy suspended material which is settleable without chemical coagulation; however the basins are equipped for chemical dosages for use when river turbidities are extremely light and difficult to remove. The basins are also equipped with automatic sludge blow-off piping and valves.

Presently sludge is discharged directly to the river. The capacity of the presedimentation basins with three basins in service will supply the flow necessary for a nominal plant capacity of 140 mgd at a retention time of two hours and fifteen minutes. Provisions have been made for future construction of a fourth basin.

Chlorine mixing basins follow the presedimentation units. The primary function of this facility is the application and mixing of large dosages of chlorine which are applied through diffusers at the head end of each mixing compartment. The basin also is equipped for application of lime and alum or ferric sulfate during critical treatability periods. The chlorine basin, composed of two parallel compartments and a center bypass has a capacity of 150 mgd.

The chlorine contact basin provides a retention time of about two hours for chlorine reaction and further precipitation of suspended material during high rates of flow. No sludge removal equipment is provided in this basin. The basin is provided with a bypass and is normally removed from service once a year for cleaning of sediment.

Four primary basins of the suspended solids contact type, chemically clarify and soften the settled and chlorinated water. Mixing, flocculation, clarification and hardness reduction are all performed in a single unit. Influent conduits permit split treatment for hardness reduction. The present split treatment operation provides for excess lime treatment of 70 percent of the water with the remaining 30 percent of the water bypassing the softening step and being blended with softener effluent. Concentrated sludge collected from the units flow by gravity to a sludge pump structure where it may be pumped to the presedimentation basins or final mixing basin, or drained directly to the river. Presently the sludge goes to the river.

Effluent from the primary basins normally flows to stabilization basin except during bypass when once annually it is removed from service for cleaning.

Final mixing capabilities are available ahead of the final basins in baffle type mixing basin. Facilities are provided for application of chemicals in the case of upset in the primary basins. This basin is also bypassed and cleaned once each year.

Two final basins furnish retention time for the final reaction of carbon dioxide and the removal of very fine suspended matter.

The flow to the basins is normally equally split and basins are operated in parallel. The basins are not equipped with sludge removal equipment and require a once-a-year shut-down for cleaning. These final basins are the least effective of all the treatment plant units.

The Florence plant contains 24 filter beds, 6 of which were constructed in 1956 with 18 of the older beds having been re-habilitated and re-equipped over the years since then. The fil-ters are used to remove the last traces of turbidity, bacteria, and color from the water. The water used to backwash the fil-ters is discharged to the river.

Finished filtered water is stored and is pumped into the Direct District by the high service pumps at the Minne Lusa Pumping Station.

The chemical building at Florence was constructed in 1956. It is equipped with chemical handling, storage, and feeding facili-ties, laboratories, offices, and instrumentation and sampling equipment. The building serves as the headquarters and control center for the superintendent, chemist and plant operators.

Platte River Treatment Plant. The Platte River Plant was placed in operation in 1968 and has a nominal capacity of 60 mgd. The plant is all under one roof, except for the clear-well. The clearwell is a separate covered structure. Completely enclosing the building has reduced maintenance and possible contamination as well as protecting the plant from freezing. Thirty-seven shallow wells having an average depth of 55 feet provide raw water at the Platte River Plant. All are 42-inch by 26-inch gravel packed with 26-inch steel pipe casing and stainless steel Layne shutter screens. Twenty-five of the well pumps are driven by electric motors. Combination drives with both electric motors and natural-gas engines are installed on the other 12 pumps.

Raw well water is pumped through a collector system terminating at the plant in a 60-inch cement lined steel pipe. All piping and electrical distribution is buried and the well houses are set above maximum Platte River flood stage.

Raw water enters the plant at the solids-contact upflow units. There are six units in all, three on each side. One of the units has a design capacity of 22.5 mgd while the other two basins

have capacities of 15 mgd. Either side can be operated using calcium selective softening or split treatment method. Sludge from the upflow units is pumped through 30,000 feet of 8-inch force main to discharge into the Missouri River. This was done to take advantage of the assimilative power of the larger river.

Water leaving the upflow basins flows to eight filters, four on each side of the plant. Two of the filters on each side of the plant contain a sand media and the remaining two a combined media of sand and anthracite. Backwashing is accomplished with a combination of air and water backwash. Backwash water is supplied from the high service pump suction well with a 15 mgd pump and air is supplied at a pressure of 5.0 psi from a centrifugal compressor. Back wash water is discharged to the Platte River.

Filtered water flows to the 6.0 mg clearwell and then to a high service pump suction well. High service pumps discharge into a common header and leaves the plant through a 60-inch transmission main.

The distribution system is divided into three major service

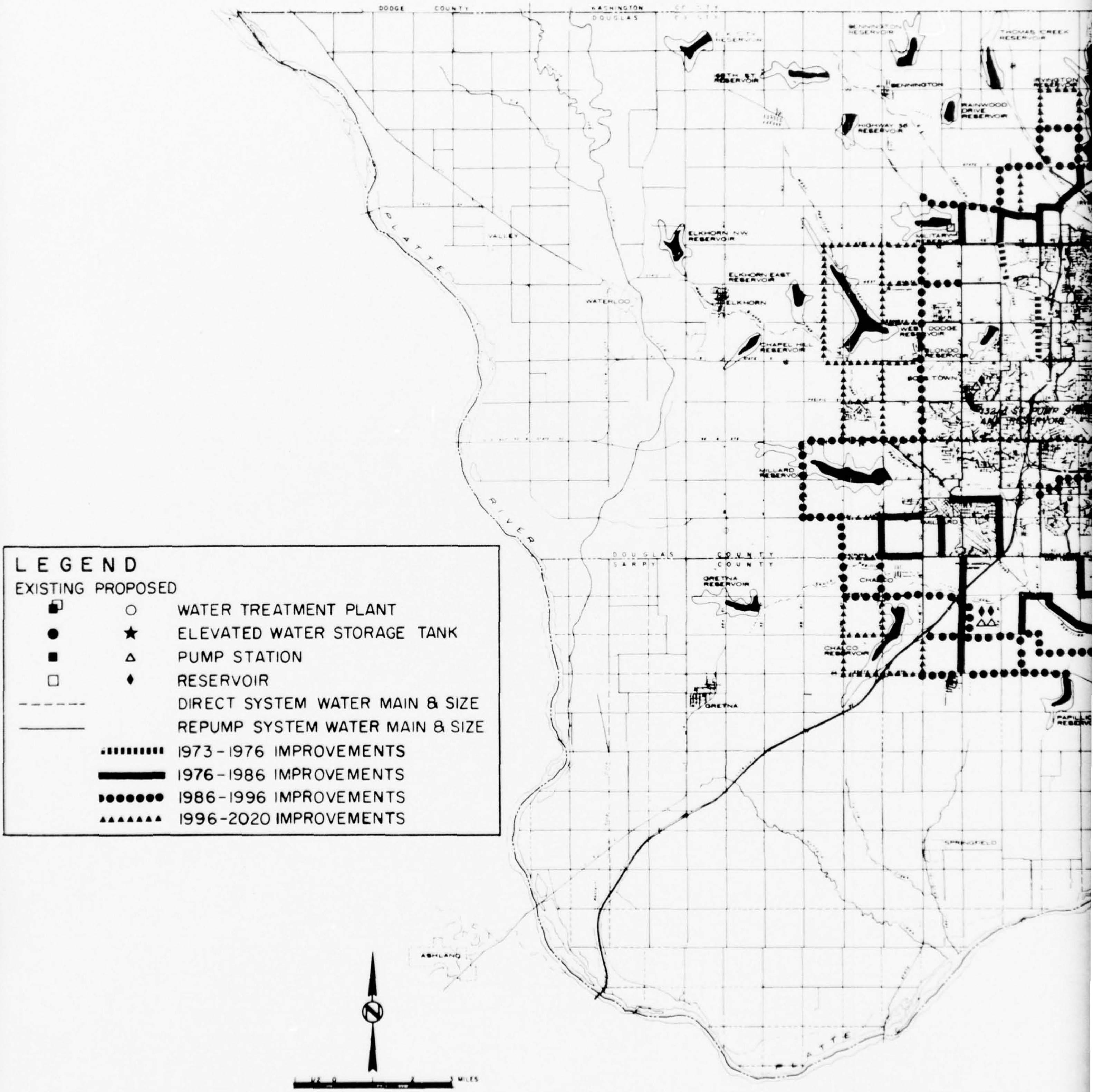
areas. They are the Direct North System, Direct South System, and the Repump System. Water can be pumped from either of the two treatment plants through the Direct North and Direct South Systems to the major production equalization reservoirs located at Omaha Field Club and Walnut Hill. The Repump System takes water that is routed through the Direct Systems and stored water in the Field Club and Walnut Hill reservoirs, and pumps it to the higher ground areas. The existing system has a total effective storage capacity of about 70 million gallons. Total pumping capacity of the Direct System and Repump System is approximately 230 and 260 mgd respectively. Pumps with gasoline, natural gas, or steam turbine engine standby power have a rated capacity of about 70 mgd in the direct systems and 104 mgd in the repump system.

Missouri River sources have the potential capability to supply all of the water requirements for the total 50-year study period. Platte River sites have limited potentials. Preliminary studies in 1972 indicated that the Platte River Valley site had an estimated supply potential of 136 million gallons a day, while the Springfield site was capable of producing 20 million gallons a day.

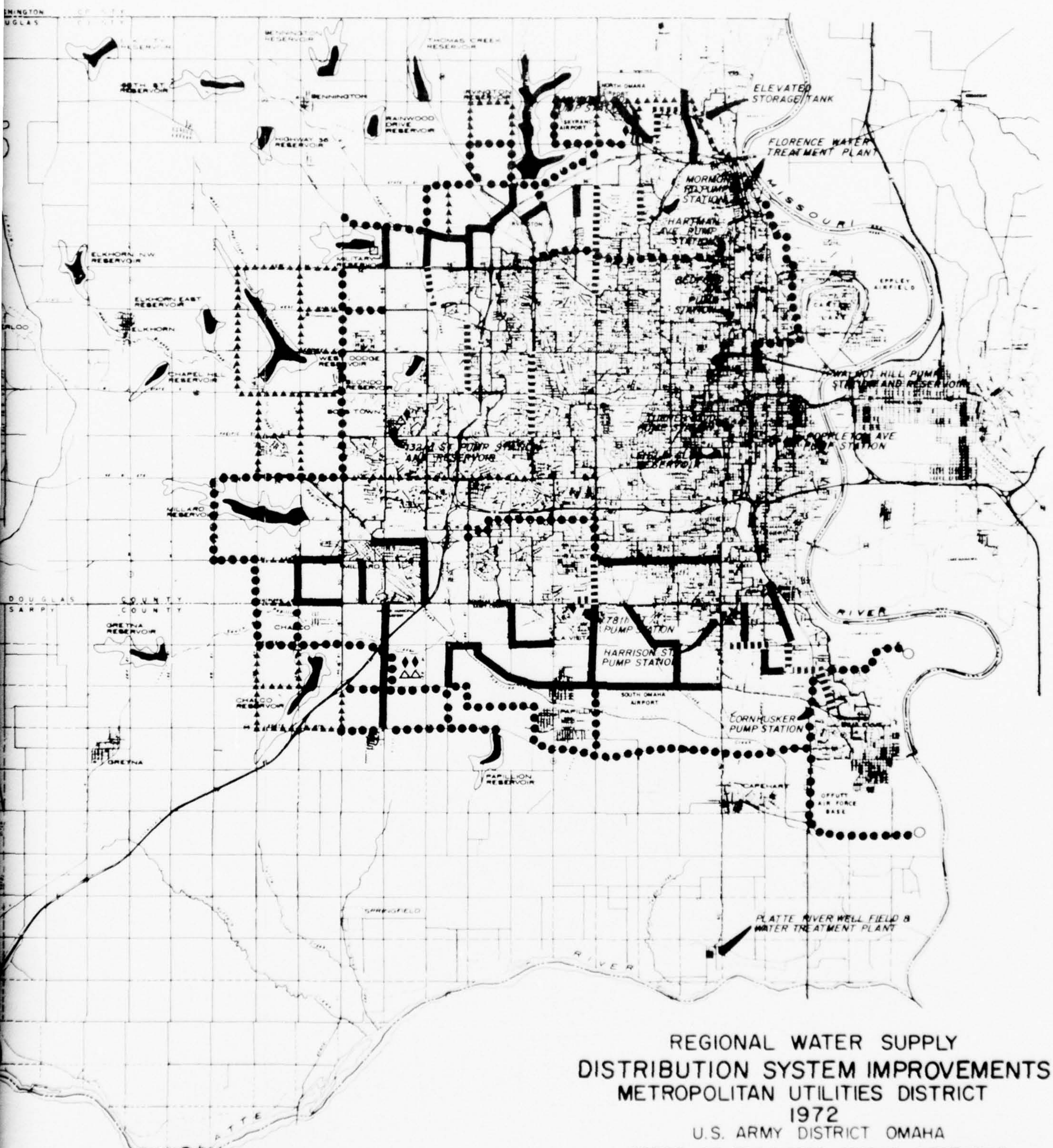
Under the recommended 1972 plan of expansion, the Platte River sites were developed to their fullest potential. If the Platte River site could not be used as a source of supply, an alternate plan provided for obtaining a future water supply from Florence Plant Additions and a new source of ground water supply on the Missouri River south of Omaha.

It was earlier recommended that the first expansion of water supply and treatment be constructed at Florence by 1982. The economics of constructing the first increment is slightly in favor of Florence and uncertainties exist regarding the availability of water from the Platte River Valley site. When the facts are known concerning the Valley site, the desirability of developing a new Platte River source of supply may be re-appraised.

The new supply will be needed around 1993 and should be ready for production when the maximum day demand reaches 300 million gallons per day. Around this same time, the 20 million gallons a day plant addition is planned for the existing Platte River Plant to keep pace with the requirements in the Direct South District. Another 50 million gallon per day treatment plant addition is expected around 2004. Additions will be needed to existing and proposed pumping



LEGEND
EXISTING PROPOSED
WATER TREATMENT PLANT
ELEVATED WATER STORAGE TANK
PUMP STATION
RESERVOIR
DIRECT SYSTEM WATER MAIN & SIZE
REPUMP SYSTEM WATER MAIN & SIZE
1973-1976 IMPROVEMENTS
1976-1986 IMPROVEMENTS
1986-1996 IMPROVEMENTS
1996-2020 IMPROVEMENTS
DODGE COUNTY
WASHINGTON COUNTY
DOUGLAS COUNTY
SARPY COUNTY
PLATTE RIVER
BENNINGTON RESERVOIR
BENNINGTON
THOMAS CREEK RESERVOIR
RAINWOOD DRIVE RESERVOIR
HIGHWAY 36 RESERVOIR
VALLEY
ELKHORN NW RESERVOIR
ELKHORN EAST RESERVOIR
ELKHORN
WATERLOO
CHAPEL HILL RESERVOIR
MILLARD RESERVOIR
GRETNA RESERVOIR
CHALCO RESERVOIR
CHALCO
GRETNA
SPRINGFIELD
ASHLAND
MILES



REGIONAL WATER SUPPLY
DISTRIBUTION SYSTEM IMPROVEMENTS
METROPOLITAN UTILITIES DISTRICT
1972
U.S. ARMY DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE II-5

2

stations and storage reservoirs to provide for total system requirements. Sometime before 2020, another 50 million gallon per day treatment expansion will be necessary.

Iowa

Harrison County has no first class cities, four second class cities, six villages and six unincorporated communities. All of the incorporated areas are served by municipal water systems employing well supplies. The unincorporated communities and rural population are served by private well supplies.

Industrial water usage in the county is minimal with no major self-supplied or municipally-supplied industries, except for feedlots having private well supplies. About 14,400 acres were irrigated in 1973. Approximately 6 percent of the total acreage was irrigated by surface water diversions from the Missouri and Boyer Rivers and Willow Creek. The remaining irrigated acres are concentrated in western Harrison County and are irrigated from wells.

The only major water related recreational area is the DeSoto National Wildlife Refuse located along the Missouri River in the southwest section of the county. Several smaller water related developments are currently in existence or being planned.

All municipal water supply and distribution systems are owned and operated by their respective city or village governments. Of the cities for which water-rate pricing information was available, all had a declining unit price billing, with the lowest rate being in a range of 12 to 35¢ per 1000 gallons.

All of the municipal systems in the county, except Dunlap, Pisgah and Woodbine, have water treatment and disinfection facilities. Of the systems which provide treatment, all but one provide iron and manganese removal and two provide softening. Dunlap provides only water stabilization and Woodbine provides only disinfection. Pisgah pumps water directly into the distribution system without prior treatment or disinfection. The untreated raw water supplies characteristically have high total dissolved solids, iron and/or manganese concentrations. A few raw water supplies have excessive sulfate concentrations. With the exception of Pisgah, all the municipally treated water supplies exceed suggested Public Health Service Drinking Water Standards for Iron, Manganese, Total Solids, and/or Sulfates. Adequate supplies of fair quality ground water exist along the Boyer and Missouri Rivers. The availability of ground water diminishes in the rest of the county.

A plan exists for serving all rural and municipal residents of Harrison County from six rural water districts. Each district would be interconnected with the other districts and treatment facilities and well supplies would be located near the ten incorporated towns. Implementation of this plan would provide essentially all residents of the county with a good quality water supply.

There are currently no known pumping facilities with standby pumping or power capabilities. No existing reuse or recycling of water or wastewater has been identified in Harrison County.

Recommended improvements for the Missouri Valley municipal system listed in a 1968 Henningson, Durham & Richardson report consisted of distribution system improvements, addition of an elevated storage tank, and improvement of the water treatment plant.

Mills County, Iowa accounts for just under 2 percent of the seven-county study area population. There are eight incorporated municipalities in Mills County representing approximately 70% of the county's 11,800 residents. Seven of these communities have public water facilities. Pacific Junction, population 560, is not on a public system.

Although the quantity of surface water exceeds ground water available in the county, there is only one supply which draws from surface water. This is the City of Glenwood, which obtains a portion of its water from Keg Creek. All other communities and rural areas utilize ground water with pumping capacities ranging from 40 gpm to 300 gpm. Irrigation wells in the alluvial aquifer along the Missouri plain are capable of producing up to 1,500 gallons per minute.

Ground water quality is generally good over roughly 60% of county's area with total dissolved solids in the 250-500 ppm range. In the balance of the county, chlorides range up to 600 ppm and sulfates up to 1000 ppm.

Three of the county's six municipal water systems are supplied totally from wells and provide no treatment. The Town of Tabor provides only disinfection. Three communities provide iron and manganese removal and disinfection. Glenwood's Pacific Junction well field provides softening, iron and manganese removal and disinfection.

The cities which provided water pricing information all have metered sales with declining block rates. The high quantity rates range from 25 to 50¢ per 1000 gallons.

The greatest use of water in the county is for agriculture purposes. A total of 3,900 acres of cropland are irrigated. Eighteen percent of this acreage is irrigated from surface water diversion. It is estimated that hogs and cattle alone consume 500,000 gallons per day in Mills County.

There are two major industrial water users in the county. The Swift Company in Glenwood uses over 600,000 gallons per day, and Henningson Foods in Malvern uses about 50,000 gpd from the municipal system. Henningson Foods also has a private supply well of about 40,000 gpd. There is only one major commercial water user in the county; the State School in Glenwood uses approximately 100,000 gallons per day.

Willow Slough is the only major water related recreational area in Mills County. This facility is 599 acres in area, 150 acres of which are in water.

A water system plan was prepared for Mills County in 1970 by Anderson Engineering Co. The basic features of this plan, which divided the county into three water service areas, are 1) greater use of ground water sources through the construction of new wells;

2) placement of additional storage facilities, and 3) interconnection of municipal water systems with 8" mains.

A 1971 report by Kirkham, Michael & Associates on the Glenwood water system recommended immediate construction of additional water storage and pumping facilities. Future improvement recommendations include abandonment of the surface water supply and treatment plant and expansion of the Pacific Junction well field capacity and treatment to 5.5 mgd by 1998.

Recommended improvements for the Malvern system listed in a 1967 report by Kirkham, Michael & Associates consisted principally of expansion and updating of the existing system.

Pottawattamie County has one first class city (Council Bluffs), three second class cities, ten villages, and seven unincorporated communities. All of the incorporated areas, except McClelland, are served by municipal water systems employing well supplies. McClelland, the unincorporated communities and the rural population are served by private well supplies. The Council Bluffs system will be summarized in a separate section.

Industrial water usage in the county is concentrated in the Council Bluffs area, with minimal industrial usage in the remainder of the county. There are three major self-supplied

industries located near Council Bluffs, with the remainder of the major industries being supplied from the Council Bluffs water system. About 3900 acres were irrigated in 1973. Approximately 18 percent of the total acreage was irrigated by surface water diversions from the West Nishnabotna River. The remaining irrigated acreage is concentrated in northwest Pottawattamie County and is irrigated from wells.

The major water related recreational areas are: Lake Manawa, located near Council Bluffs; Wilson Island and Longs Landing, located along the Missouri River; and Arrowhead Park, located near Neola. Several other water related recreational areas are located along the Missouri River.

All municipal water supply distribution systems are owned and operated by their respective city or village governments. Of the cities for which water rate pricing information was available, all had declining unit pricing with increasing water consumption. The lowest unit price ranged from 20¢ per 1000 gallons at Treynor to 70¢ per 1000 gallons at Macedonia.

Four municipal systems (Hancock, Macedonia, Treynor and Underwood) pump water directly from well supplies to their distribution

system without prior treatment or disinfection. Three municipal systems (Crescent, Neola, and Oakland) provide only disinfection and four systems (Avoca, Carson, Minden and Walnut) provide both treatment and disinfection. Of the four systems providing treatment, all provide iron and manganese removal with Avoca and Minden providing additional softening. The finished waters from all four municipal treatment facilities are characteristically hard. Untreated raw water supplies within the county have high concentrations of total solids, iron, and manganese. Well water supplies at Crescent, Hancock, Macedonia, Neola, Oakland, Treynor, and Underwood exceed recommended limits for total solids, iron, and/or manganese. Adequate supplies of fair quality ground water exist along the Missouri River. A large variance in water availability and quality exists in the remainder of the county.

A plan exists for serving rural and municipal residents of Pottawattamie County, exclusive of the Council Bluffs area, from eight rural water districts. Each rural district would be interconnected with the other districts. District water supply sources and treatment facilities would be located near existing towns in each district and would supply both municipal and rural residents in the

district. Implementation of this plan would supply rural residents of the county with a good quality water supply and improve existing municipal systems.

There are currently no known pumping facilities with standby pumping or power capabilities. No reuse or recycling of water has been identified in Pottawattamie County, except for the Iowa Power and Electric Power Generation Plant south of Council Bluffs which recycles water in the winter for ice melting purposes.

Recommended improvements for the Avoca municipal system listed in a 1971 Kirkham, Michael & Associates Study and Report consisted mainly of distribution system improvements and the addition of another elevated storage facility.

Council Bluffs. All of the Council Bluffs municipal water supply is treated by the Narrows Station Treatment Plant which has a capacity of 17 mgd. Raw water supply is primarily the Missouri River with some supplemental well water used during the winter months to raise the water temperature to lessen icing problems. The treatment plant provides clarification, softening, filtration, and chlorination of the raw water.

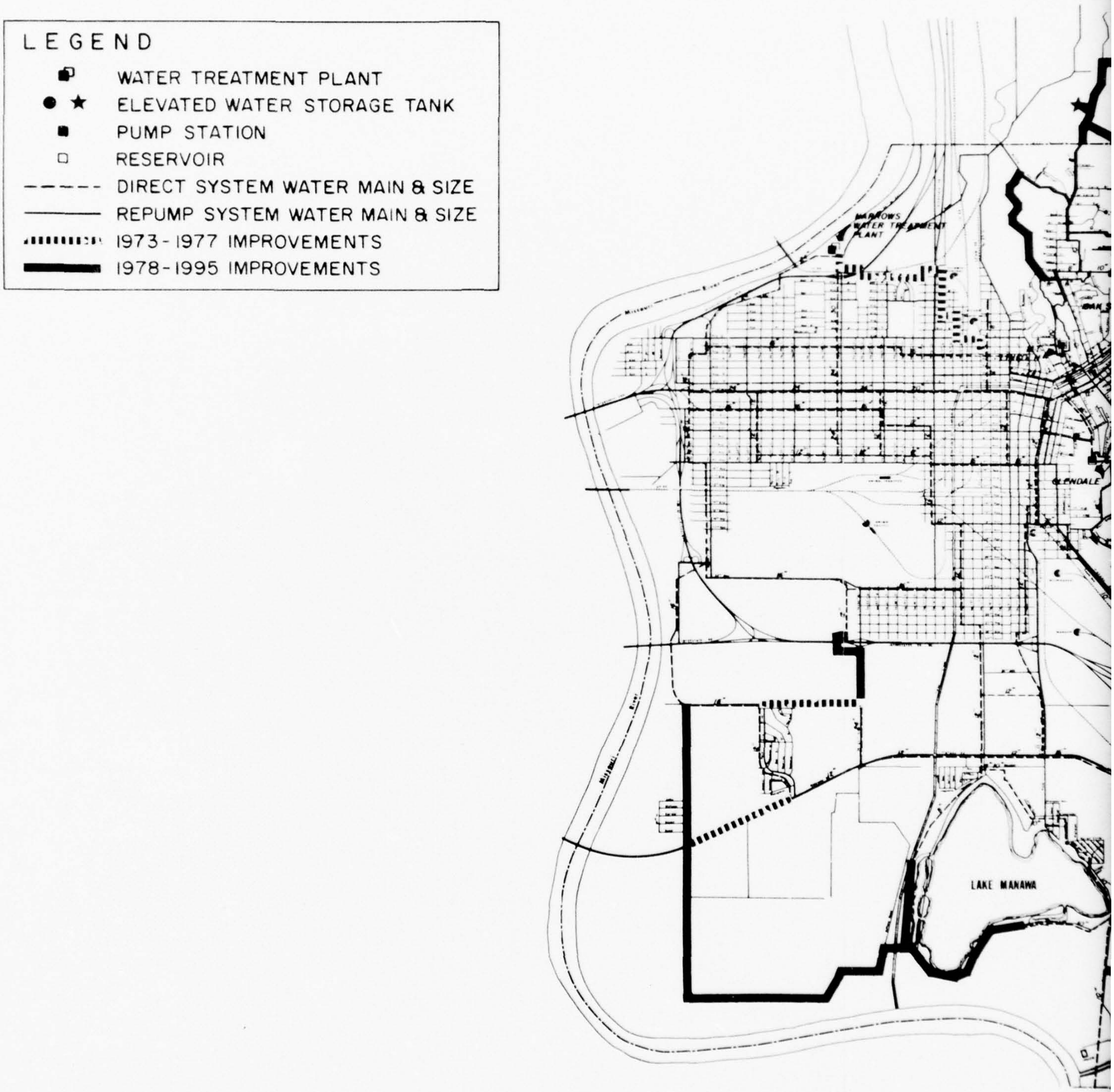
The Council Bluffs system has two 2 mg ground level storage reservoirs, two 200,000 gallon elevated tanks, and 1.6 mg of

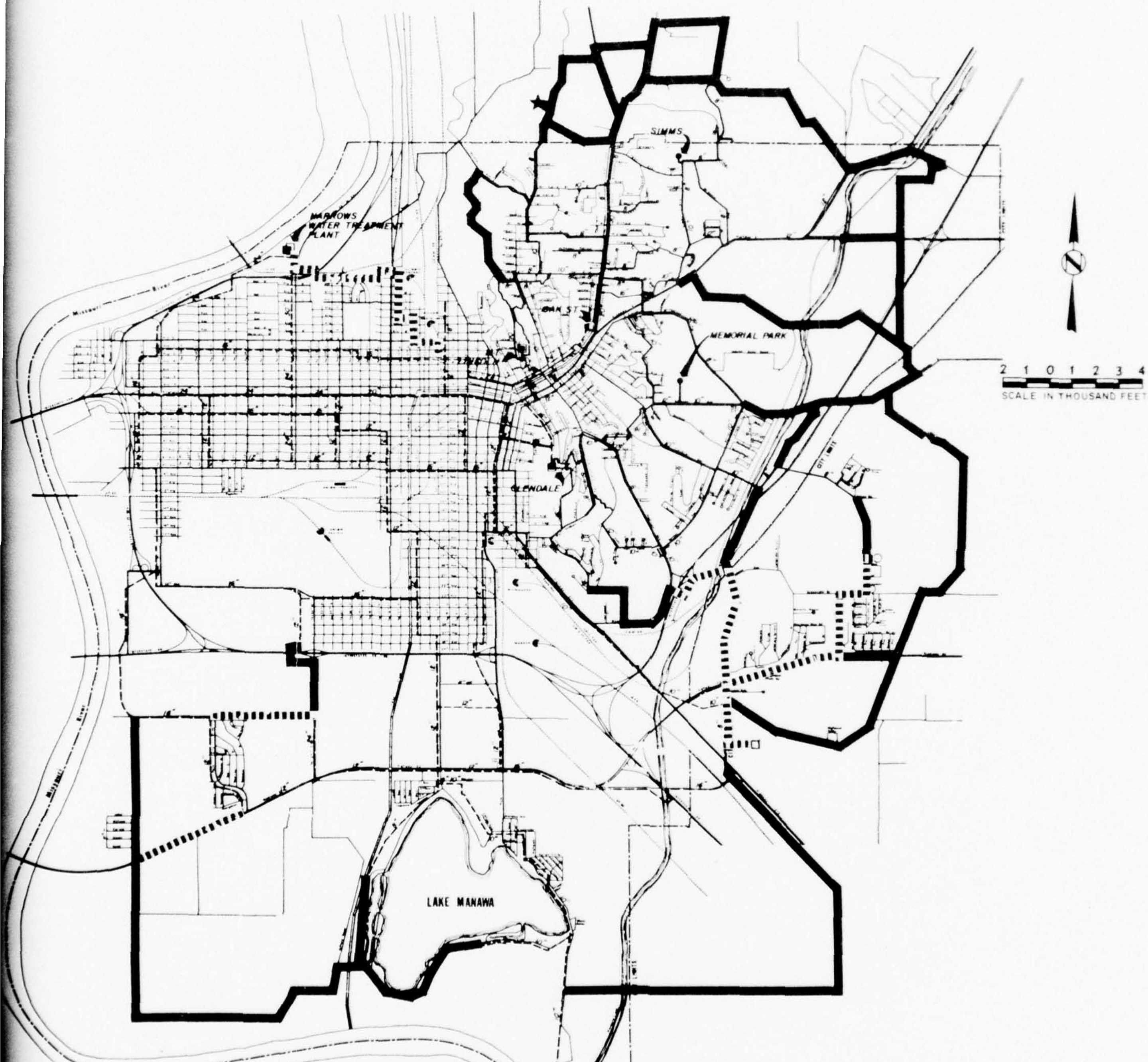
storage in the treatment plant clearwell. The Council Bluffs distribution system is divided into the direct and repump districts. Water is pumped directly from the Narrows Station Plant clearwell into the direct system and the Glendale and Mt. Lincoln ground level reservoirs. The repump district is served by three pump stations taking water from the direct district. The two elevated storage tanks serve the repump district. Total pumping capacities of the direct and repump systems are approximately 17.5 mgd and 4.7 mgd respectively. Pump(s) with gasoline or natural gas engine standby power have a rated capacity of about 5.4 mgd in the direct system and 3.1 mgd in the repump system.

Council Bluffs' 1972 Water Distribution System Master Plan basically recommends expansion of treatment, distribution, and storage facilities to accommodate increasing water demands and growth of the service area.

Probable supply source is the Missouri River at the existing Narrows Station site. This recommendation was based upon the following:

Any water treatment plant constructed downstream of the Narrows


LEGEND
WATER TREATMENT PLANT
ELEVATED WATER STORAGE TANK
PUMP STATION
RESERVOIR
DIRECT SYSTEM WATER MAIN & SIZE
REPUMP SYSTEM WATER MAIN & SIZE
1973-1977 IMPROVEMENTS
1978-1995 IMPROVEMENTS
GLENDALE
LAKE MANAWA



REGIONAL WATER SUPPLY
DISTRIBUTION SYSTEM IMPROVEMENTS
COUNCIL BLUFFS, IOWA
1972
U.S. ARMY DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE II-6

2

Plant for the treatment of Missouri River surface water would have to treat diluted waste water and/or sewage treatment plant effluent. Surface water intakes are not recommended until secondary treatment is being conducted upstream from the intake.

Ground water from wells along the Missouri River is very hard and contains much iron and manganese. Total hardness ranges from 472 to 522 mg/l as $CaCO_3$; iron is at 5.0 to 8.0 mg/l; and manganese is at 0.7 to 1.3 mg/l. The cost of treating this water would require about a 40 percent increase in chemical costs over the Narrow's Plant. Pumping costs would also be slightly higher from a downstream site. Labor costs would double with a new site whereas only a small staff increase is required for an expansion at the existing Narrows Station.

The distribution system feeder mains could not be appreciably reduced in size with a new source of supply south of the City. Residential growth in the Mosquito Creek Valley is closer to the Narrows Plant and present anticipated industrial growth in the south can be served adequately from the present source of supply without undue feeder main construction. Possibly sometime in the distant future, if southerly development continues to move

further south, it may become economically feasible to locate a plant in the south sector.

Other findings and recommendations of the Master Plan are summarized below.

The Council Bluffs area has shown a substantial population increase over the past decade. Population statistics based upon the U. S. Census Bureau's 1970 figures, indicate that an estimated 59,932 people are served by the Council Bluffs water department. Another 5,370 people are living in the Council Bluffs vicinity who are not served by the City water system. It is entirely possible that these people could be served within the next few years, thereby raising the population served by the City to 66,000. Population forecasts estimate that the number of people served could reach as high as 84,330 by the year 1995.

Residential growth is expected primarily in the high ground area north and east of the present developed portions of the City while most of the industrial growth is expected in the flats south of the City.

Water statistical records for the existing water system were studied and future water requirements were estimated. Anticipated

population increases and customer water consumption increases indicate that the Council Bluffs water requirements will increase to 13.66 million gallons by 1995. Maximum day demands are estimated to increase to 21.86 million gallons by 1995. It is estimated that the 1995 maximum day system demands will be split with 14.68 million gallons required in the Direct District and 7.18 million gallons in the Repump District. The study indicates that the existing water supply and treatment facilities will not be capable of satisfying the projected water requirements.

RELIABILITY

Non-Metro Reliability. Municipal water supply system reliability was assessed on the basis of existing storage and supply adequacy, the existence of auxiliary standby equipment, disinfection capability and the quality of water being supplied to the residential and industrial commercial customers. The firm well capacity of each municipal system was compared with the 1973 maximum day demand to determine supply adequacy. There are no specific standards or criteria to stipulate the amount and type of storage that is required to properly handle peak demands. Some states have adopted a policy that total water storage should equal an average day's supply. Other agencies have stated that the combined water

delivered from storage and pumping should be able to meet the required fire flow rate for each level of service with a residual pressure of 30 psi. Because of the additional reliability that elevated storage affords over repump facilities an average day's supply in elevated storage was considered to be the most reliable method of insuring fire protection and operation storage for non-metro area water systems and was used as the criteria for determining storage adequacy. For a metropolitan system, it would become uneconomical to store the large water requirements in an elevated tank.

The capability of the municipal system to provide disinfection as a means of preventing possible contamination was also included in this assessment. Table II-15 is a synopsis of existing municipal reliability, indicating that most of the systems could conceivably have serious storage, supply, quality and/or contamination problems. There are only three existing systems not displaying some type of deficiency in terms of their reliableness.

The majority of the municipal systems will need comprehensive management and planning in order to rectify present deficiencies and provide reliable service in the future. Table II-15 indicates cities having or currently formulating some type of water supply

TABLE II-15

MUNICIPAL WATER SUPPLY RELIABILITY ASSESSMENT

COUNTY	CITY	INADEQUATE SUPPLY CAPACITY	INADEQUATE STORAGE CAPACITY	NO AUXILIARY STAND-BY FACILITIES	INADEQUATE WATER QUALITY	NO DISINFECTION	EXISTING PLAN OR WATER SUPPLY STUDY
CASS							X
	ALVO	X	X	X	X	X	X
	AVOCA	X		N/A	X	X	
	EAGLE	N/A	X	N/A	X	X	
	ELMWOOD	X	X	X	X	X	
	GREENWOOD		X			X	
	LOUISVILLE		X	X	X	X	
	MURDOCK		X	N/A	X	X	
	MURRAY			N/A	X	X	
	NEHAWKA	X		N/A	X		
	PLATTSMOUTH				X		X
	UNION			N/A		X	
	WEEPING WATER	X		X	X	X	
DOUGLAS							
	BENNINGTON			X	X	X	X
	ELKHORN					X	X
	VALLEY		X	N/A	X	X	
	WATERLOO		X	N/A	X	X	
SARPY							
	BELLEVUE						X
	PAPILLION		X		X		X
	SPRINGFIELD		X	N/A	X	X	X
	GRETNA		X	N/A		X	X
WASHINGTON							X
	ARLINGTON		X	N/A	X	X	X
	BLAIR				X		X
	FORT CALHOUN	X		N/A	X		X
	HERMAN			N/A			
	KENNARD	X	X	X	X	X	

N/A NOT AVAILABLE

TABLE II-15 (Cont'd)
MUNICIPAL WATER SUPPLY RELIABILITY ASSESSMENT

COUNTY	CITY	INADEQUATE SUPPLY CAPACITY	INADEQUATE STORAGE CAPACITY	NO AUXILIARY STAND-BY FACILITIES	INADEQUATE WATER QUALITY	NO DISINFECTION	EXISTING PLAN OR WATER SUPPLY STUDY
HARRISON							X
	DUNLAP		X	N/A	X	X	X
	LITTLE SIOUX	X		N/A	X		
	LOGAN			X	X		
	MAGNOLIA	X	X	N/A	X		
	MISSOURI VALLEY		X	X	X		
	MODALE		X	N/A	X		
	MONDAMIN			N/A	X		
	PERSIA			X	X		
	PISGAH			N/A		X	
	WOODBINE		X	X	X		
MILLS							X
	EMERSON			X	X	X	
	GLENWOOD		X	N/A	X		X
	HASTINGS	X		N/A		X	
	HENDERSON	X		X		X	
	MALVERN		X	N/A	X		X
	SILVER CITY		X	N/A	X		
	TABOR			N/A	X		
POTTAWATTAMIE							X
	AVOCA		X	N/A			X
	CARSON	X	X	N/A			
	CRESCENT	X		X	X		
	HANCOCK			N/A	X	X	
	MACEDONIA			X	X	X	
	MINDEN			N/A	X		
	NEOLA		X	N/A	X		
	OAKLAND		X	N/A	X		X
	TREYNOR		X	X	X	X	
	UNDERWOOD	X	X	N/A	X	X	
	WALNUT		X	X	X		
N/A NOT AVAILABLE							

plan. The systems exhibiting some type of unreliableness, as listed in Table II-15, and a lack of planning are potential problem areas.

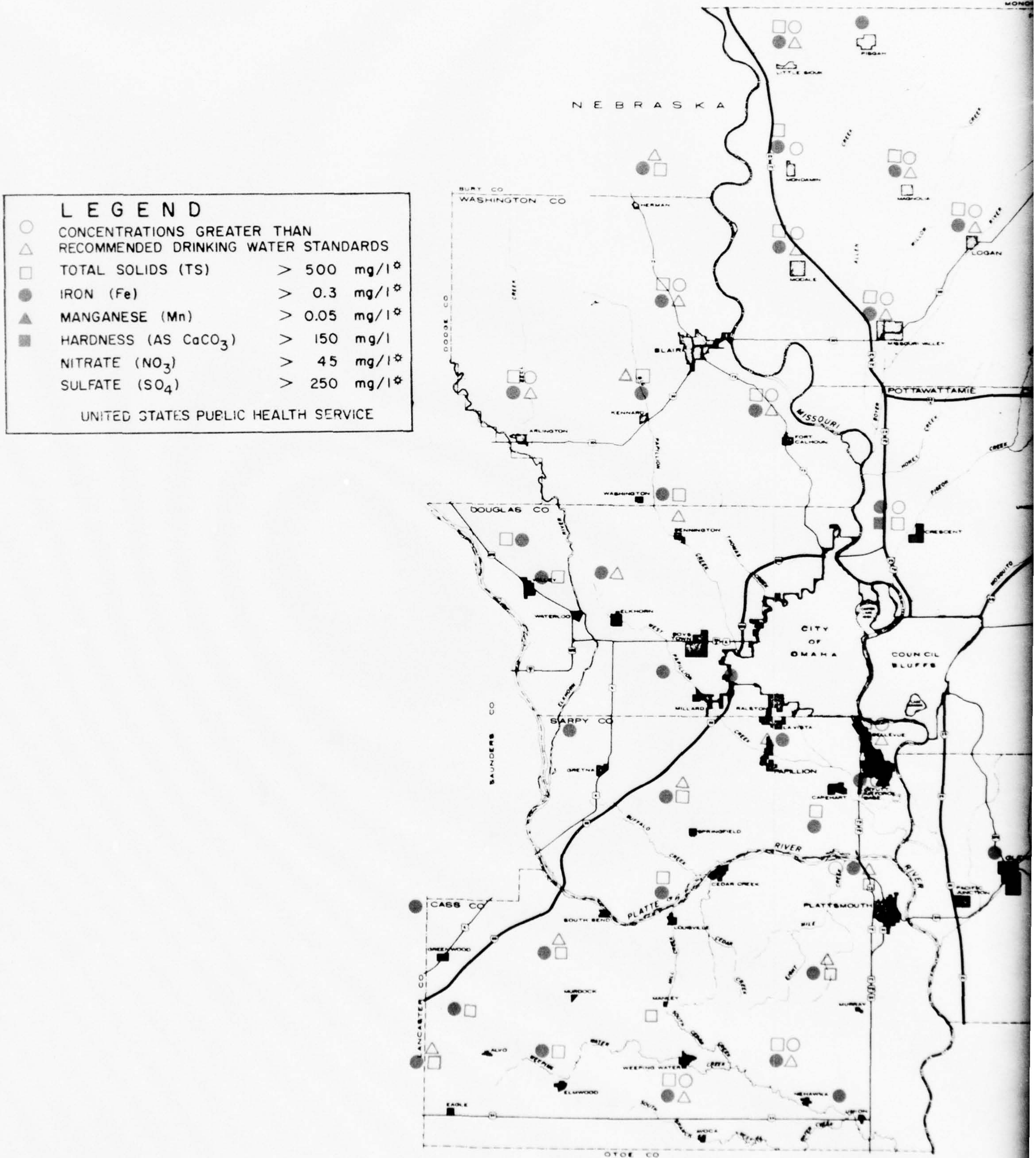
Metro-Area Reliability. The MUD and Council Bluffs systems provide reliable service to the metro area through efficient operation and maintenance of their systems. Both systems have formulated Master Plans to govern future expansion which will be required to meet the growing water requirements in Metropolitan Omaha and Council Bluffs.

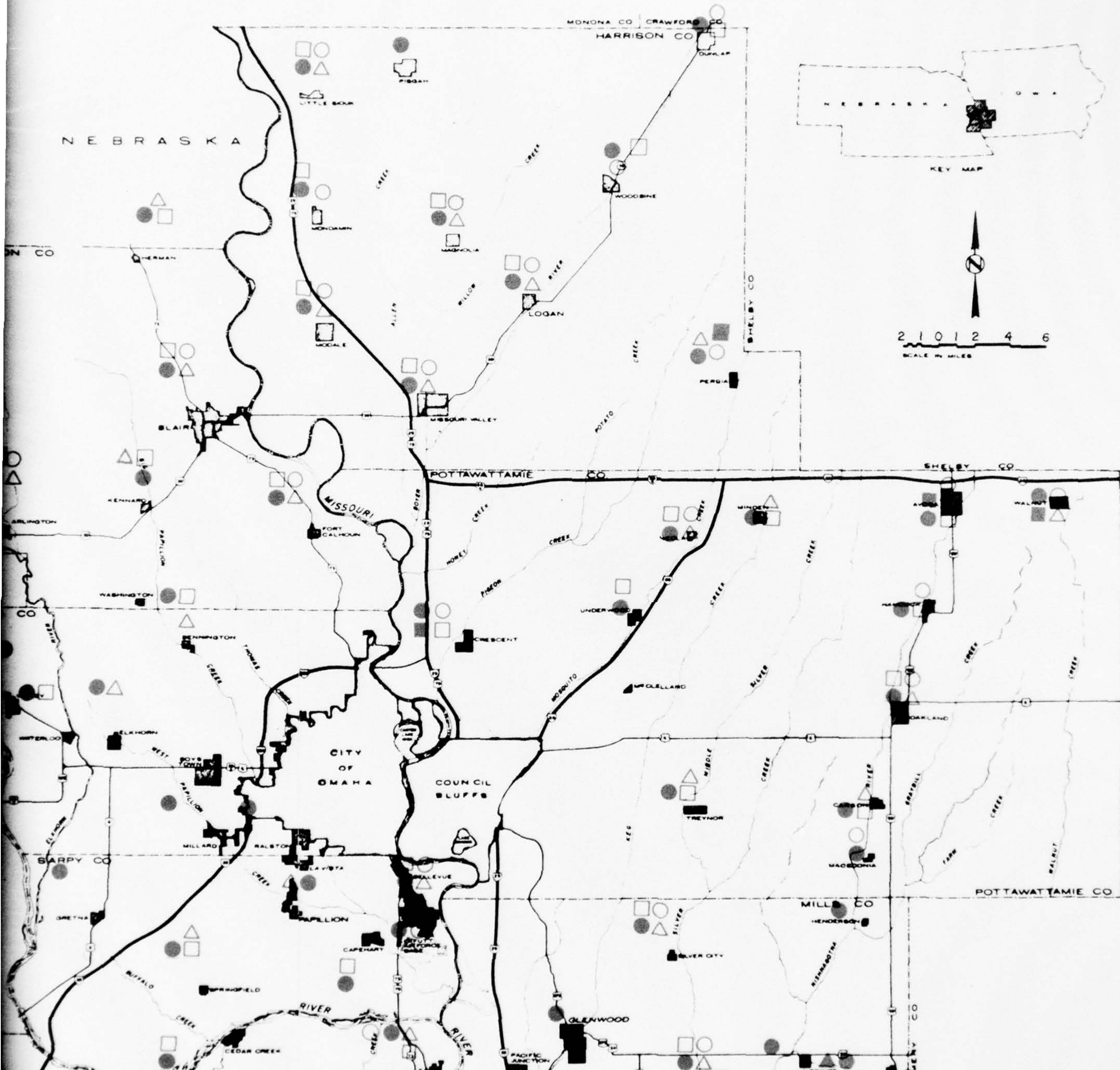
QUALITY AND QUANTITY SUMMARY

Figure II-7 illustrates a comparison of average raw water quality for municipal sources in the area with the United States Public Health Service (USPHS) 1962 drink water standards for total solids, iron, manganese, nitrate and sulfate. Municipal water sources having a hardness in excess of 150 mg/l for which some type of softening is recommended are also shown. USPHS limits for iron, manganese, total solids, and sulfate have primarily an aesthetic basis. Iron and manganese can cause taste, odor, and discoloration problems when in excess of the recommended standards. Excessive total dissolved solids may render a water unsatisfactory for many industrial purposes and produce disagreeable tastes.

Sulfates in combination with either magnesium or sodium impart a bitter taste to the water. If present in sufficient quantities, the water may act as a laxative for people not accustomed to drinking it. Nitrate in excess of the 45 mg/l limit in drinking water consumed by infants may cause a condition known as methemoglobinemia. High nitrate concentrations are also often indicative of contamination by human or animal waste water. Water having a hardness in excess of 150 mg/l is considered hard and softening should be considered for best beneficial residential and industrial use.

The quality of water is such that in most instances iron and manganese removal would be necessary for the water to meet USPHS recommended limits. Table II-16 summarizes the raw water quality at existing municipal wells. This municipal well analysis indicates that ground water in the study area is characteristically hard. Wells located along the Missouri River exhibit high concentrations of total solids, iron, and manganese in addition to hardness. Water from municipal wells along the Platte and Elkhorn Rivers is of a higher quality (lower iron and total solids concentrations) than that from wells along the Missouri River. The water quality in much of Washington and Harrison counties is characterized by high


LEGEND
CONCENTRATIONS GREATER THAN
RECOMMENDED DRINKING WATER STANDARDS
TOTAL SOLIDS (TS) > 500 mg/l*
IRON (Fe) > 0.3 mg/l*
MANGANESE (Mn) > 0.05 mg/l*
HARDNESS (AS $CaCO_3$) > 150 mg/l
NITRATE (NO_3) > 45 mg/l*
SULFATE (SO_4) > 250 mg/l*
UNITED STATES PUBLIC HEALTH SERVICE
NEBRASKA
WASHINGTON CO
DOUGLAS CO
SARPY CO
CASS CO
SAUNDERS CO
OTOE CO
POTTAWATTAMIE
MISSOURI
CITY OF OMAHA
COUNCIL BLUFFS
PLATTE RIVER
BLAIR
PLATTSMOUTH
WEEPING WATER
LOGAN
MISSOURI VALLEY
CRESCENT
WATERLOO
ELKHORN
PAPILLION
SPRINGFIELD
CEDAR CREEK
SOUTH BEND
GRETNA
ARLINGTON



REGIONAL WATER SUPPLY

MUNICIPAL RAW WATER QUALITY

U.S. ARMY DISTRICT OMAHA

CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE II-7

TABLE II-16

MUNICIPAL GROUND WATER QUALITY AND WELL CAPACITY

COUNTY	CITY	TS (mg/l)	Fe (mg/l)	Mn (mg/l)	HARDNESS AS $CaCO_3$ (mg/d)	NO_3 (mg/l)	SO_4 (mg/l)	NUMBER OF WELLS	CAPACITY RANGE (GPM)
HARRISON	DUNLAP	618	.02	.12	465	29	101	2	215-230
	LITTLE SIOUX	740	6.70	.36	570	< 1	150	1	42
	LOGAN	548	2.08	1.05	436	11	94	4	N/A
	MAGNOLIA	529	.37	.07	424	< 1	57	1	35
	MISSOURI VALLEY	725	1.47	.44	559	5	149	3	525-570
	MODALE	532	7.00	.71	440	< 1	26	2	75
	MONDAMIN	803	.07	.41	635	4	113	2	175-130
	PERSIA	735	.71	.05	404	10	252	3	15
	PISGAH	387	.06	< .05	364	< 1	19	2	150
	WOODBINE	530	.05	.12	455	20	115	2	180-250
MILLS	EMERSON	402	.03	.01	322	46	40	2	150
	GLENWOOD	370	.11	.05	284	23	4	3	N/A
	HASTINGS	390	.07	< .05	312	16	67	1	50
	HENDERSON	395	.05	< .01	296	38	37	1	40
	MALVERN	505	3.09	1.28	398	1	105	8	25-60
	SILVER CITY	649	5.50	.63	503	< 1	140	2	60-140
	TABOR	339	.15	.07	274	4	42	2	150
POTTAWATTAMIE	AVOCA	765	4.20	3.13	570	3	260	3	N/A
	CARSON	377	.67	.43	325	1	49	3	N/A
	CRESCENT	1470	.12	.15	600	< 1	710	1	100
	HANCOCK	576	.17	.08	465	15	119	4	90
	MACEDONIA	597	.04	< .05	482	6	180	2	70
	MINDEN	415	1.16	.27	360	16	43	8	10-20
	NEOLA	681	.34	.88	515	37	131	3	75-100
	OAKLAND	633	1.55	.39	338	< 1	188	5	50-100
	TREYNOR	364	.66	.17	298	5	39	2	125-135
	UNDERWOOD	427	.02	.81	375	14	31	2	20-50
	WALNUT	1625	1.15	.02	705	< 1	740	2	140-230

TABLE II-16 (Cont'd)

MUNICIPAL GROUND WATER QUALITY AND WELL CAPACITY

COUNTY	CITY	TS (mg/l)	Fe (mg/l)	Mn (mg/l)	HARDNESS AS $CaCO_3$ (mg/d)	NO_3 (mg/l)	SO_4 (mg/l)	NUMBER OF WELLS	CAPACITY RANGE (GPM)
CASS	ALVO	370	0.1	0.10	240	< 1	2	1	50
	AVOCA	530	0.34	0.10	357	12	10	3	N/A
	EAGLE	420	0.80	0.30	372	< 1	36	2	N/A
	ELMWOOD	318	0.10	0.10	189	16	2	3	60-120
	GREENWOOD	405	0.0	0.00	256	1	13	2	100-350
	LOUISVILLE	425	0.2	0.65	272	< 1	12	2	250-350
	MANLEY								
	MURDOCK	293	0.45	0.10	154	4	8	2	50
	MURRAY	455	11.5	0.1	352	7	18	3	18-50
	NEHAWKA	535	5.9	1.9	380	< 1	23	1	40
	PLATTSMOUTH	505	8.65	2.00	398	< 1	34	3	480-600
	UNION	393	0.05	0.05	284	9	8	2	35-40
	WEEPING WATER	210	0.15	0.10	114	< 1	< 1	2	85
DOUGLAS	BENNINGTON	423	0.77	0.20	315	< 1	20	4	80-100
	ELKHORN	383	0.20	0.03	285	< 1	10	4	50-600
	MILLARD	373	0.07	0.00	267	< 1	4	6	125-1000
	RALSTON	422	0.02	0.02	264	< 1	24	5	125-375
	VALLEY	343	0.0	0.43	208	< 1	43	3	450
	WATERLOO	390	0.30	0.80	256	0.0	38	4	250
SARPY	BELLEVUE	643	10.83	1.17	335	< 1	56	6	460-600
	GRETNA	425	0.0	0.0	284	< 1	21	2	375-400
	OFFUTT	518	9.7	0.0	430	< 1	27	5	450-1000
	PAPILLION	380	0.52	0.0	279	4	11	5	100-260
	PLATTE RIVER WELL FIELD		0.01	0.13	214	3	100	37	700-2200
	SPRINGFIELD	365	0.35	0.10	260	2	3	3	150-500
WASHINGTON	ARLINGTON	550	0.40	0.35	362	< 1	91	3	250-325
	BLAIR	780	6.94	0.78	445	< 1	135	11	95-425
	FORT CALHOUN	567	3.34	0.20	404	0.0	4	3	20-50
	HERMAN	402	1.50	0.70	324	0.0	9	2	100-200
	KENNARD	480	3.15	0.80	348	0.0	8	2	50-200

N/A - NOT AVAILABLE

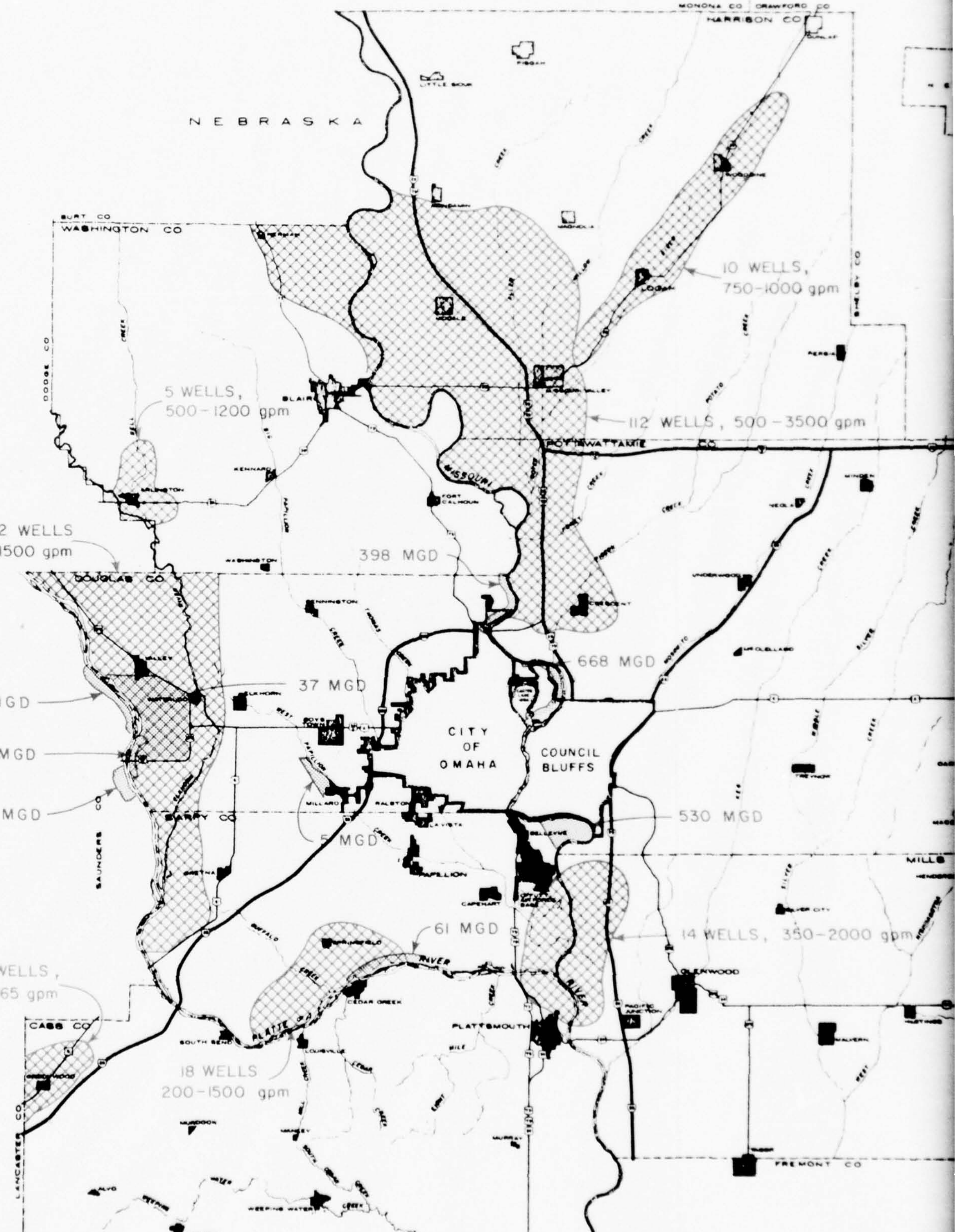
concentrations of total solids, iron, manganese, and hardness. High concentrations of iron, manganese, and total solids also exist in the municipal well water from along the West Nishnabotna River and Mosquito Creek in Pottawattamie County and the Weeping Water Creek in southern Cass County.

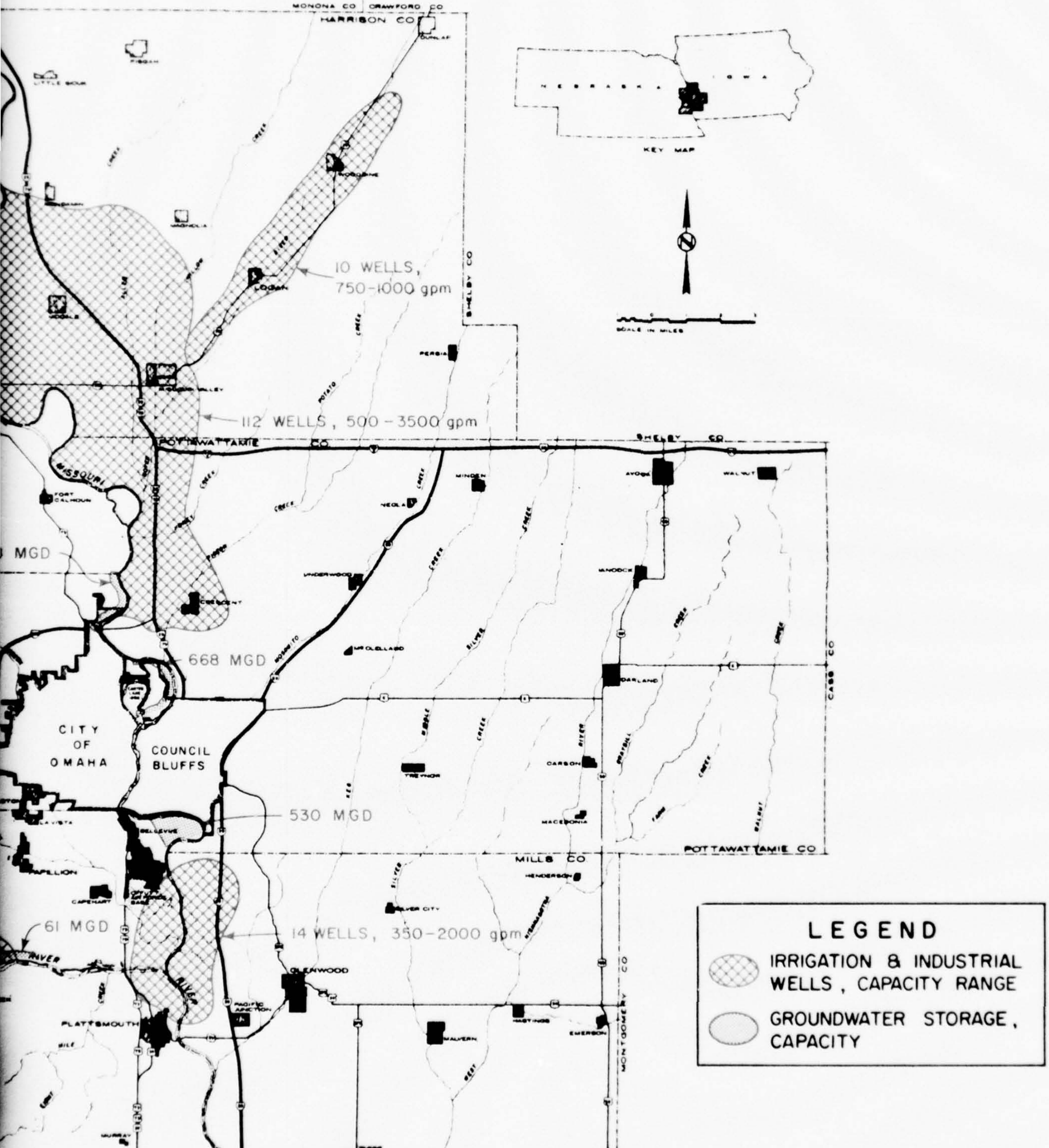
Local aquifers of potentially good water quality may exist as evidenced by wells at Pisgah, Hastings, and Gretna, but in general the ground water quality of the study area is poor and would require treatment to meet USPHS drinking water standards.

The capacities of existing municipal wells are summarized in Table II-16 and that of irrigation wells in Figure II-8. Existing irrigation wells indicate the presence of aquifers, capable of yielding from 500-1000 gpm, along the Missouri River in Washington and Harrison counties, between the Platte and Elkhorn Rivers in Western Douglas and Sarpy counties, along the lower Platte in Southern Sarpy county, adjacent to the Platte and Missouri Rivers south of Bellevue, and along the Boyer River in southeastern Harrison County. Ground water availability is limited in the remaining portions of the study area as evidenced by existing wells of generally low capacity.

Table II-25 summarizes by county the municipal, industrial and agricultural crop irrigation supply capabilities of the region. Municipal supply capabilities are the total treatment plant capacity or well capacity in the case of untreated well sources. Only three systems in the seven counties (Council Bluffs and Glenwood, Iowa, and Omaha's MUD) have surface supply sources and all are augmented to some extent by well water. Note that the total municipal supply capacity of 258.06 mgd exceeds the 1973 maximum day demand of 189.76 mgd listed in Table II-24 by 36 percent. Of the 68.30 mgd reserve capacity, 42.93 mgd was in the MUD system, 4.68 mgd in the Council Bluffs system, and 20.69 mgd in other municipal systems.

Industrial supply capacities are mostly well capacity or maximum allowable surface water diversion rate since most of the 1,690.37 mgd potential is to be used untreated (or with minimal treatment) as cooling water. More than 1,640 mgd of the surface water diversion capability is to be used as cooling water by the power plants located along the Missouri River. The irrigation supply capacities are well capacities and maximum surface water diversion rates as registered with the respective states.


NEBRASKA
MONONA CO
CRAWFORD CO
HARRISON CO
BURT CO
WASHINGTON CO
DODGE CO
DOUGLAS CO
POTTAWATTAMIE CO
SARPY CO
SAUNDERS CO
CASS CO
LANCASTER CO
OTOE CO
FREMONT CO
MILLS
SHELBY CO
10 WELLS,
750-1000 gpm
5 WELLS,
500-1200 gpm
112 WELLS, 500-3500 gpm
102 WELLS
500-1500 gpm
398 MGD
668 MGD
37 MGD
238 MGD
37 MGD
77 MGD
5 MGD
530 MGD
CITY
OF
OMAHA
COUNCIL
BLUFFS
61 MGD
14 WELLS, 350-2000 gpm
12 WELLS,
75-165 gpm
18 WELLS
200-1500 gpm
MISSOURI
PLATTE
RIVER
BLAIR
FORT CALHOUN
WASHINGTON
KENNARD
ARLINGTON
CRESCENT
UNDERWOOD
MINDEN
NEOLA
ELKHORN
MILLARD
RALSTON
LA VISTA
PAPILLION
BELLEVUE
GRETNA
CAPEHART
CEDAR CREEK
SOUTH BEND
LOUISVILLE
PLATTSMOUTH
GLENWOOD
PACIFIC JUNCTION
MALVERN
MURRAY
WEEPING WATER
ELMWOOD
EAGLE
ALVO
MURDOCK
MANLEY
NEHAWKA
UNION
LOGAN
MODALE
MISSOURI VALLEY
MAGNOLIA
PISGAH
LITTLE SIOUX
PERSIA
McCLELLAND
TREYNOR
SILVER CITY
HENDERSON
HASTINGS
TABOR
BUFFALO
CREEK



REGIONAL WATER SUPPLY
GROUNDWATER STORAGE & WITHDRAWAL
U. S. ARMY DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE II-8

2

TABLE II-17
PRESENT WATER DEMANDS – MILLION GALLONS PER DAY

CASS COUNTY

MUNICIPALITIES	1973 AVERAGE DAY	1973 MAX. DAY
SERVED BY MUNICIPAL SYSTEM		
RESIDENTIAL		
IN-HOUSE	1.076	1.399
LAWN IRRIGATION	0.199	1.241
INDUSTRIAL-COMMERCIAL	0.180	0.270
TOTAL	1.455	2.910
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
INDUSTRIAL-COMMERCIAL		
TOTAL		
TOTAL MUNICIPAL	1.455	2.910
RURAL		
SERVED BY PRIVATE SYSTEM		
RESIDENTIAL		
IN-HOUSE	0.326	0.424
LAWN IRRIGATION	0.058	0.344
TOTAL	0.384	0.768
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
TOTAL		
LIVESTOCK WATERING BY PRIVATE SYSTEM	0.765	1.530
LIVESTOCK WATERING BY RURAL WATER DIST.		
TOTAL RURAL	1.149	2.298
TOTAL RURAL AND MUNICIPAL	2.604	5.208
CROP IRRIGATION	2.262	14.743
SELF SUPPLIED INDUSTRIES		
POWER PLANTS		
COOLING WATER		
OTHER		
OTHER INDUSTRIES		
TOTAL INDUSTRIES		
RECREATIONAL		
TOTAL	4.866	19.951

TABLE II-18
PRESENT WATER DEMANDS – MILLION GALLONS PER DAY

DOUGLAS COUNTY

	1973	
MUNICIPALITIES	AVERAGE DAY	MAX. DAY
SERVED BY MUNICIPAL SYSTEM		
RESIDENTIAL		
IN-HOUSE	36.663	47.661
LAWN IRRIGATION	9.138	51.050
INDUSTRIAL-COMMERCIAL	23.331	42.605
TOTAL	69.132	141.316
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
INDUSTRIAL-COMMERCIAL		
TOTAL		
TOTAL MUNICIPAL	69.132	141.316
RURAL		
SERVED BY PRIVATE SYSTEM		
RESIDENTIAL		
IN-HOUSE	0.442	0.575
LAWN IRRIGATION	0.078	0.465
TOTAL	0.520	1.040
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
TOTAL		
LIVESTOCK WATERING BY PRIVATE SYSTEM	0.550	1.100
LIVESTOCK WATERING BY RURAL WATER DIST.		
TOTAL RURAL	1.070	2.140
TOTAL RURAL AND MUNICIPAL	70.202	143.456
CROP IRRIGATION	8.723	56.855
SELF SUPPLIED INDUSTRIES		
POWER PLANTS		
COOLING WATER	540.420	724.744
OTHER	0.610	0.818
OTHER INDUSTRIES	6.010	9.015
TOTAL INDUSTRIES	547.040	734.577
RECREATIONAL		
TOTAL	625.965	934.888

TABLE II-19
PRESENT WATER DEMANDS - MILLION GALLONS PER DAY

SARPY COUNTY

MUNICIPALITIES	1973 AVERAGE DAY	1973 MAX. DAY
SERVED BY MUNICIPAL SYSTEM		
RESIDENTIAL		
IN-HOUSE	8.658	11.256
LAWN IRRIGATION	1.989	11.387
INDUSTRIAL-COMMERCIAL	0.409	0.651
TOTAL	11.056	23.294
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
INDUSTRIAL-COMMERCIAL		
TOTAL		
TOTAL MUNICIPAL	11.056	23.294
RURAL		
SERVED BY PRIVATE SYSTEM		
RESIDENTIAL		
IN-HOUSE	0.547	0.711
LAWN IRRIGATION	0.097	0.577
TOTAL	0.644	1.288
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
TOTAL		
LIVESTOCK WATERING BY PRIVATE SYSTEM	0.719	1.438
LIVESTOCK WATERING BY RURAL WATER DIST.		
TOTAL RURAL	1.363	2.726
TOTAL RURAL AND MUNICIPAL	12.419	26.020
CROP IRRIGATION	6.790	44.256
SELF SUPPLIED INDUSTRIES		
POWER PLANTS		
COOLING WATER	106.777	207.360
OTHER	1.008	1.800
OTHER INDUSTRIES	20.000	30.000
TOTAL INDUSTRIES	127.785	239.160
RECREATIONAL		
TOTAL	146.994	309.436

TABLE II - 20
PRESENT WATER DEMANDS – MILLION GALLONS PER DAY

WASHINGTON COUNTY

MUNICIPALITIES	1973 AVERAGE DAY	1973 MAX. DAY
SERVED BY MUNICIPAL SYSTEM		
RESIDENTIAL		
IN-HOUSE	1.074	1.396
LAWN IRRIGATION	0.190	1.201
INDUSTRIAL-COMMERCIAL	0.138	0.207
TOTAL	1.402	2.804
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
INDUSTRIAL-COMMERCIAL		
TOTAL		
TOTAL MUNICIPAL	1.402	2.804
RURAL		
SERVED BY PRIVATE SYSTEM		
RESIDENTIAL		
IN-HOUSE	0.253	0.329
LAWN IRRIGATION	0.045	0.267
TOTAL	0.298	0.597
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
TOTAL		
LIVESTOCK WATERING BY PRIVATE SYSTEM	1.225	2.450
LIVESTOCK WATERING BY RURAL WATER DIST.		
TOTAL RURAL	1.523	3.047
TOTAL RURAL AND MUNICIPAL	2.925	5.851
CROP IRRIGATION	3.491	22.754
SELF SUPPLIED INDUSTRIES		
POWER PLANTS		
COOLING WATER	440.650	518.400
OTHER		
OTHER INDUSTRIES		
TOTAL INDUSTRIES		
RECREATIONAL		
TOTAL	447.066	547.005

TABLE II-21
PRESENT WATER DEMANDS — MILLION GALLONS PER DAY

HARRISON COUNTY

	1973	
MUNICIPALITIES	AVERAGE DAY	MAX. DAY
SERVED BY MUNICIPAL SYSTEM		
RESIDENTIAL		
IN-HOUSE	0.658	0.855
LAWN IRRIGATION	0.116	0.987
INDUSTRIAL-COMMERCIAL	0.271	0.406
TOTAL	1.045	2.248
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
INDUSTRIAL-COMMERCIAL		
TOTAL		
TOTAL MUNICIPAL	1.045	2.248
RURAL		
SERVED BY PRIVATE SYSTEM		
RESIDENTIAL		
IN-HOUSE	0.345	0.449
LAWN IRRIGATION	0.061	0.363
TOTAL	0.406	0.812
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
TOTAL		
LIVESTOCK WATERING BY PRIVATE SYSTEM	1.165	2.330
LIVESTOCK WATERING BY RURAL WATER DIST.		
TOTAL RURAL	1.571	3.142
TOTAL RURAL AND MUNICIPAL	2.616	5.390
CROP IRRIGATION	13.732	89.503
SELF SUPPLIED INDUSTRIES		
POWER PLANTS		
COOLING WATER		
OTHER		
OTHER INDUSTRIES		
TOTAL INDUSTRIES		
RECREATIONAL		
TOTAL	16.348	94.893

TABLE II-22
PRESENT WATER DEMANDS – MILLION GALLONS PER DAY

MILLS COUNTY

MUNICIPALITIES	1973 AVERAGE DAY	1973 MAX. DAY
SERVED BY MUNICIPAL SYSTEM		
RESIDENTIAL		
IN-HOUSE	0.708	0.920
LAWN IRRIGATION	0.125	0.578
INDUSTRIAL-COMMERCIAL	0.997	1.496
TOTAL	1.830	2.994
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
INDUSTRIAL-COMMERCIAL		
TOTAL		
TOTAL MUNICIPAL	1.830	2.994
RURAL		
SERVED BY PRIVATE SYSTEM		
RESIDENTIAL		
IN-HOUSE	0.218	0.283
LAWN IRRIGATION	0.039	0.231
TOTAL	0.257	0.514
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
TOTAL		
LIVESTOCK WATERING BY PRIVATE SYSTEM	1.020	2.040
LIVESTOCK WATERING BY RURAL WATER DIST.		
TOTAL RURAL	1.277	2.554
TOTAL RURAL AND MUNICIPAL	3.107	5.548
CROP IRRIGATION	3.171	20.668
SELF SUPPLIED INDUSTRIES		
POWER PLANTS		
COOLING WATER		
OTHER		
OTHER INDUSTRIES	0.920	1.380
TOTAL INDUSTRIES	0.920	1.380
RECREATIONAL		
TOTAL	7.198	27.596

TABLE II-23
PRESENT WATER DEMANDS – MILLION GALLONS PER DAY

POTTAWATTAMIE COUNTY

MUNICIPALITIES	1973 AVERAGE DAY	1973 MAX. DAY
SERVED BY MUNICIPAL SYSTEM		
RESIDENTIAL		
IN-HOUSE	4.622	6.008
LAWN IRRIGATION	0.815	3.013
INDUSTRIAL-COMMERCIAL	3.969	5.179
TOTAL	9.406	14.200
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
INDUSTRIAL-COMMERCIAL		
TOTAL		
TOTAL MUNICIPAL	9.406	14.200
RURAL		
SERVED BY PRIVATE SYSTEM		
RESIDENTIAL		
IN-HOUSE	0.696	0.905
LAWN IRRIGATION	0.123	0.733
TOTAL	0.819	1.638
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
TOTAL		
LIVESTOCK WATERING BY PRIVATE SYSTEM	3.350	6.700
LIVESTOCK WATERING BY RURAL WATER DIST.		
TOTAL RURAL	4.169	8.338
TOTAL RURAL AND MUNICIPAL	13.575	22.538
CROP IRRIGATION	3.873	25.244
SELF SUPPLIED INDUSTRIES		
POWER PLANTS		
COOLING WATER	90.720	116.640
OTHER	0.350	1.440
OTHER INDUSTRIES	1.114	1.671
TOTAL INDUSTRIES	92.184	119.751
RECREATIONAL		
TOTAL	109.632	167.533

TABLE II-24
PRESENT WATER DEMANDS – MILLION GALLONS PER DAY

TOTAL STUDY AREA

MUNICIPALITIES	1973 AVERAGE DAY	1973 MAX. DAY
SERVED BY MUNICIPAL SYSTEM		
RESIDENTIAL		
IN-HOUSE	53.459	69.495
LAWN IRRIGATION	12.572	69.457
INDUSTRIAL-COMMERCIAL	29.295	50.814
TOTAL	95.326	189.766
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
INDUSTRIAL-COMMERCIAL		
TOTAL		
TOTAL MUNICIPAL	95.326	189.766
RURAL		
SERVED BY PRIVATE SYSTEM		
RESIDENTIAL		
IN-HOUSE	2.827	3.676
LAWN IRRIGATION	.501	2.980
TOTAL	3.328	6.657
SERVED BY RURAL WATER DISTRICT		
RESIDENTIAL		
IN-HOUSE		
LAWN IRRIGATION		
TOTAL		
LIVESTOCK WATERING BY PRIVATE SYSTEM	8.794	17.588
LIVESTOCK WATERING BY RURAL WATER DIST.		
TOTAL RURAL	12.122	24.245
TOTAL RURAL AND MUNICIPAL	107.448	214.011
CROP IRRIGATION	42.042	274.023
SELF SUPPLIED INDUSTRIES		
POWER PLANTS		
COOLING WATER	1178.567	1567.144
OTHER	2.732	4.058
OTHER INDUSTRIES	28.044	42.066
TOTAL INDUSTRIES	1209.343	1613.268
RECREATIONAL		
TOTAL	1358.833	2101.302

TABLE II-25

1973 STUDY AREA WATER SUPPLY CAPABILITIES [1]

(MILLIONS GALLONS / DAY)

	HARRISON	MILLS	POTTAWATTAMIE	CASS	DOUGLAS	SARPY	WASHINGTON	TOTAL
MUNICIPAL								
WELL SUPPLIES	4.31	2.11	3.20	6.07	6.67	75.05	2.65	100.06
SURFACE SUPPLIES		1.00	17.00		140.00			158.00
INDUSTRIAL								
WELL SUPPLIES [2]		3.34	13.95	0.09	2.16	23.11	0.58	43.23
SURFACE SUPPLIES			116.64		804.74	207.36	518.40	1647.14
AGRICULTURAL								
CROP IRRIGATION								
WELL SUPPLIES [2]	160.08	31.97	44.71	22.43	166.85	67.45	31.74	525.23
SURFACE SUPPLIES [3]	12.76	7.63	10.61	14.01	11.43	11.41	15.29	83.14
TOTAL	177.15	46.05	206.11	42.60	1131.85	384.38	568.66	2556.80

1. SUPPLY CAPABILITIES OF SMALL PRIVATE WELLS OR IMPOUNDMENTS FOR RESIDENTIAL AND LIVESTOCK WATERING USERS ARE NOT INCLUDED IN THIS TABLE.
2. WELL SUPPLIES REGISTERED WITH THE STATE OF NEBRASKA, DEPARTMENT OF WATER RESOURCES OR THE IOWA NATURAL RESOURCES COUNCIL.
3. SURFACE DIVERSIONS REGISTERED WITH THE STATE OF NEBRASKA, DEPARTMENT OF WATER RESOURCES OR THE IOWA NATURAL RESOURCES COUNCIL.

SECTION III

FUTURE QUANTITY AND QUALITY REQUIREMENTS

SECTION III

FUTURE QUANTITY AND QUALITY REQUIREMENTS

Projections of future area water requirements in this chapter are divided into two sections; baseline projection using Growth Concept A population projections and usage data from engineering reports, and the effect of alternative Growth Concepts on baseline consumption.

BASELINE PROJECTIONS

Municipal. Residential and municipally supplied industrial water consumption estimates are shown for 1995 and 2020 in Table III-1 based upon Concept A population predictions. Future per capita usages are derived from report data, municipal water supply records and engineering estimates.

Historically, water consumption in most area systems has shown a steady rise due to both population and per capita usage increases. Reports on area systems project a continued increase in per capita consumption as shown in Figure III-1. Usage in the MUD and Council Bluffs systems, as shown in respective planning reports, is expected to increase at the rate of one gallon per capita per day (gpcd) per year. A one gpcd per year increase is applied from 1973 to 1995

TABLE III-1
RESIDENTIAL AND MUNICIPALLY
SUPPLIED INDUSTRIAL WATER USAGE

COUNTY	1973			1995			2020		
	POPULATION SERVED	AVE DAY (MGD)	MAX. DAY (MGD)	POPULATION SERVED	AVE DAY (MGD)	MAX. DAY (MGD)	POPULATION SERVED	AVE DAY (MGD)	MAX. DAY (MGD)
CASS	18,792	1.839	3.678	20,562	2.618	5.236	21,526	2.778	5.556
DOUGLAS									
MUD	387,000	68.638	140.328	515,950	105.586	236.167	634,473	147.082	329.104
OTHER	12,930	1.014	2.028	17,428	2.006	4.012	15,768	2.181	4.362
TOTAL COUNTY	399,930	69.652	142.356	533,378	107.592	240.179	650,241	149.263	333.466
SARPY									
MUD	43,000	7.795	16.740	200,056	40.924	91.541	237,600	54.774	123.244
OTHER	31,480	3.905	7.810	15,386	1.965	3.930	23,143	3.014	6.028
TOTAL COUNTY	74,480	11.700	24.582	215,442	42.889	95.471	260,743	57.788	129.272
WASHINGTON	13,833	1.700	3.401	17,759	2.794	5.587	19,348	3.043	6.087
HARRISON	16,366	1.451	3.060	16,834	2.068	4.424	17,727	2.155	4.605
MILLS	12,758	2.087	3.508	11,961	3.137	5.448	11,418	3.483	5.967
POTTAWATTAMIE									
COUNCIL BLUFFS	62,103	8.390	12.315	75,350	12.207	19.373	94,570	18.611	30.097
OTHER	21,807	1.835	3.523	26,724	4.337	8.705	28,927	4.861	9.295
TOTAL COUNTY	83,910	10.225	15.838	102,074	16.155	27.461	123,497	21.955	36.938
TOTAL	620,069	98.654	196.423	918,000	.642	384.423	1,104,500	241.982	.344

PER CAPITA WATER CONSUMPTION PROJECTIONS

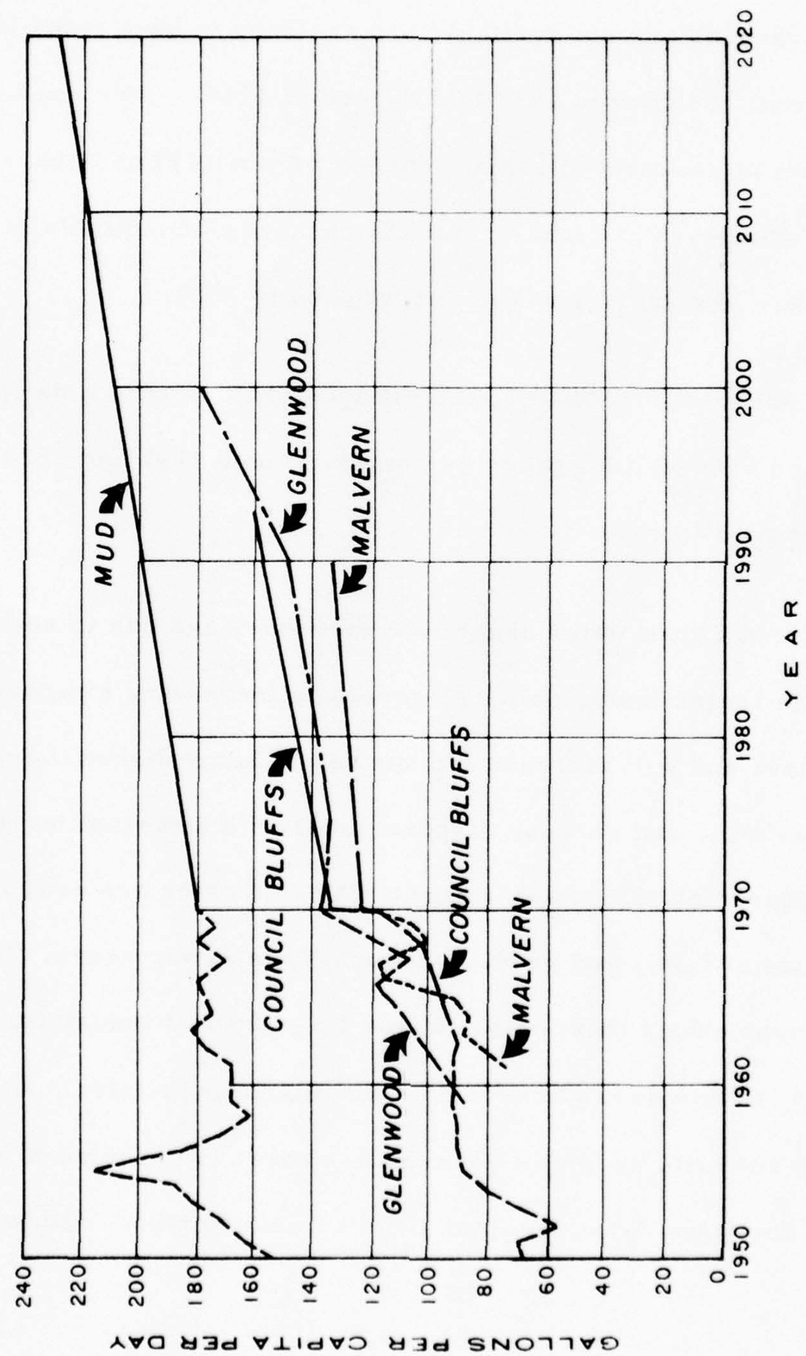


FIGURE III - 1

for all municipalities except where specific municipal report predictions differ. Municipalities for which planning reports and water use records are not available are assumed to have rates increasing from 100 gpcd in 1973 to 122 gpcd in 1995. Per capita consumption is assumed to remain constant from 1995 or report target level, whichever is higher, to 2020; except in Council Bluffs where the one gallon per year increase is continued to 2020.

Rural and non-municipally supplied villages are assigned a daily consumption rate of 100 gallons per capita in both 1995 and 2020, up from 60 gpcd in 1973.

Historical and future water usage rate increases are due to several factors. In larger municipalities, generally increasing standards of living have and will increase the number of home dishwashers, clothes washers, and garbage disposal units with attendant increases in water consumption. Substantial quantities of water are used in maintenance of lawns and gardens especially in newer areas. Increasing populations must be supported by additional industrial development, in this area often "wet" food related industries. Assurance of an adequate supply of good quality water is expected to substantially increase rural residential water consumption. Although

cost of water service to rural users is likely to be high in terms of hook-up for and average monthly billing, typical rate structures with a high minimum billing and declining block rate will tend to make the cost of increased water consumption appear "cheap" to rural users. For these reasons, per capita water consumption is expected to continue to increase. In-house and out-of-house residential and industrial-commercial usage are assumed to increase proportional to current levels as shown in county summaries, Tables III-2 through III-9, and city summaries, Appendix 1, Section B, except where available report data indicate otherwise.

Self-supplied Industrial

Because of quantity and quality requirements some industries find it more feasible to develop their own source of supply. Such self-supplied industrial users tend to use large quantities of cooling water. Future growth of self-supplied industry as a whole is very unpredictable and likely will not grossly affect total water availability in the study area with the exception of two large industries, and crop irrigation.

Electrical power generating and coal gasification plants could have a pronounced impact upon study area water requirements in 1995

CASS COUNTY

TABLE III - 2

PRESENT AND FUTURE WATER DEMANDS, MGD

	1973		1995		2020	
MUNICIPALITIES	AVERAGE DAY	MAX. DAY	AVERAGE DAY	MAX. DAY	AVERAGE DAY	MAX. DAY
SERVED BY MUNICIPAL SYSTEM						
RESIDENTIAL						
IN-HOUSE	1.076	1.399	1.384	1.799	1.494	1.942
LAWN IRRIGATION	0.199	1.241	0.255	1.596	0.277	1.726
INDUSTRIAL-COMMERCIAL	0.180	0.270	0.234	0.351	0.252	0.378
TOTAL	1.455	2.910	1.873	3.746	2.023	4.046
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE			0.080	0.104	0.088	0.114
LAWN IRRIGATION			0.014	0.089	0.015	0.098
INDUSTRIAL-COMMERCIAL			0.011	0.017	0.012	0.018
TOTAL			0.105	0.210	0.115	0.230
TOTAL MUNICIPAL	1.455	2.910	1.978	3.956	2.138	4.276
RURAL						
SERVED BY PRIVATE SYSTEM						
RESIDENTIAL						
IN-HOUSE	0.326	0.424				
LAWN IRRIGATION	0.058	0.344				
TOTAL	0.384	0.768				
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE			0.544	0.707	0.544	0.707
LAWN IRRIGATION			0.096	0.573	0.096	0.573
TOTAL			0.640	1.280	0.640	1.280
LIVESTOCK WATERING BY PRIVATE SYSTEM	0.765	1.530	0.575	1.150	1.225	2.450
LIVESTOCK WATERING BY RURAL WATER DIST.			0.765	1.530	0.765	1.530
TOTAL RURAL	1.149	2.298	1.980	3.960	2.630	5.260
TOTAL RURAL AND MUNICIPAL	2.604	5.208	3.958	7.916	4.768	9.536
CROP IRRIGATION	2.262	14.743	3.122	20.346	4.072	26.538
SELF SUPPLIED INDUSTRIES						
POWER PLANTS						
COOLING WATER						
OTHER						
OTHER INDUSTRIES						
TOTAL INDUSTRIES						
RECREATIONAL						
TOTAL	4.866	19.951	7.080	28.262	8.840	36.074

DOUGLAS COUNTY

TABLE III - 3

PRESENT AND FUTURE WATER DEMANDS, MGD

MUNICIPALITIES	1973		1995		2020	
	AVERAGE DAY	MAX. DAY	AVERAGE DAY	MAX. DAY	AVERAGE DAY	MAX. DAY
SERVED BY MUNICIPAL SYSTEM						
RESIDENTIAL						
IN-HOUSE	36.663	47.661	57.195	74.353	83.197	108.155
LAWN IRRIGATION	9.138	51.050	14.226	97.598	20.696	139.371
INDUSTRIAL-COMMERCIAL	23.331	42.605	35.420	66.725	45.030	85.260
TOTAL	69.132	141.316	106.841	238.676	148.923	332.786
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE						
LAWN IRRIGATION						
INDUSTRIAL-COMMERCIAL						
TOTAL						
TOTAL MUNICIPAL	69.132	141.316	106.841	238.676	148.923	332.786
RURAL						
SERVED BY PRIVATE SYSTEM						
RESIDENTIAL						
IN-HOUSE	0.442	0.575	0.638	0.829	0.289	0.376
LAWN IRRIGATION	0.078	0.465	0.113	0.673	0.051	0.304
TOTAL	0.520	1.040	0.751	1.502	0.340	0.680
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE						
LAWN IRRIGATION						
TOTAL						
LIVESTOCK WATERING BY PRIVATE SYSTEM	0.550	1.100	0.965	1.930	1.430	2.860
LIVESTOCK WATERING BY RURAL WATER DIST.						
TOTAL RURAL	1.070	2.140	1.716	3.432	1.770	3.540
TOTAL RURAL AND MUNICIPAL	70.202	143.456	108.557	242.108	150.693	336.326
CROP IRRIGATION	8.723	56.855	12.038	78.460	15.701	102.339
SELF SUPPLIED INDUSTRIES						
POWER PLANTS						
COOLING WATER	540.420	724.744	540.420	724.744	N.A.	N.A.
OTHER	0.610	0.818	0.610	0.818	N.A.	N.A.
OTHER INDUSTRIES	6.010	9.015	6.010	9.015	6.010	9.015
TOTAL INDUSTRIES	547.040	734.577	547.040	734.577	6.010	9.015
RECREATIONAL						
TOTAL	625.965	934.888	667.635	1055.145	172.404	447.680

SARPY COUNTY

TABLE III - 4

PRESENT AND FUTURE WATER DEMANDS, MGD

MUNICIPALITIES	1973		1995		2020	
	AVERAGE DAY	MAX. DAY	AVERAGE DAY	MAX. DAY	AVERAGE DAY	MAX. DAY
SERVED BY MUNICIPAL SYSTEM						
RESIDENTIAL						
IN-HOUSE	8.658	11.256	22.941	29.823	31.731	41.250
LAWN IRRIGATION	1.989	11.387	5.650	38.695	7.799	60.484
INDUSTRIAL-COMMERCIAL	0.409	0.651	13.834	26.025	17.952	26.928
TOTAL	11.056	23.294	42.425	94.543	57.482	128.662
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE						
LAWN IRRIGATION						
INDUSTRIAL-COMMERCIAL						
TOTAL						
TOTAL MUNICIPAL	11.056	23.294	42.425	94.543	57.482	128.662
RURAL						
SERVED BY PRIVATE SYSTEM						
RESIDENTIAL						
IN-HOUSE	0.547	0.711	0.394	0.512	0.259	0.337
LAWN IRRIGATION	0.097	0.577	0.070	0.417	0.046	0.273
TOTAL	0.644	1.288	0.464	0.929	0.305	0.610
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE						
LAWN IRRIGATION						
TOTAL						
LIVESTOCK WATERING BY PRIVATE SYSTEM	0.719	1.438	1.260	2.520	1.870	3.740
LIVESTOCK WATERING BY RURAL WATER DIST.						
TOTAL RURAL	1.363	2.726	1.724	3.449	2.175	4.350
TOTAL RURAL AND MUNICIPAL	12.419	26.020	44.149	98.992	59.657	133.012
CROP IRRIGATION	6.790	44.256	9.370	61.074	12.222	79.661
SELF SUPPLIED INDUSTRIES						
POWER PLANTS						
COOLING WATER	106.777	207.360				
OTHER	1.008	1.800				
OTHER INDUSTRIES	20.000	30.000	20.000	30.000	20.000	30.000
TOTAL INDUSTRIES	127.785	239.160	20.000	30.000	20.000	30.000
RECREATIONAL						
TOTAL	146.994	309.436	73.519	190.066	91.879	242.673

WASHINGTON COUNTY

TABLE III - 5
PRESENT AND FUTURE WATER DEMANDS, MGD

	1973		1995		2020	
MUNICIPALITIES	AVERAGE DAY	MAX. DAY	AVERAGE DAY	MAX. DAY	AVERAGE DAY	MAX. DAY
SERVED BY MUNICIPAL SYSTEM						
RESIDENTIAL						
IN-HOUSE	1.074	1.396	1.408	1.830	1.566	2.036
LAWN IRRIGATION	0.190	1.201	0.249	1.575	0.276	1.751
INDUSTRIAL-COMMERCIAL	0.138	0.207	0.184	0.276	0.205	0.308
TOTAL	1.402	2.804	1.841	3.681	2.047	4.095
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE			0.351	0.456	0.376	0.489
LAWN IRRIGATION			0.063	0.395	0.074	0.438
INDUSTRIAL-COMMERCIAL			0.047	0.071	0.054	0.081
TOTAL			0.461	0.922	0.504	1.008
TOTAL MUNICIPAL	1.402	2.804	2.302	4.603	2.551	5.103
RURAL						
SERVED BY PRIVATE SYSTEM						
RESIDENTIAL						
IN-HOUSE	0.253	0.329				
LAWN IRRIGATION	0.045	0.267				
TOTAL	0.298	0.597				
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE			0.418	0.543	0.418	0.543
LAWN IRRIGATION			0.074	0.441	0.074	0.441
TOTAL			0.492	0.984	0.492	0.984
LIVESTOCK WATERING BY PRIVATE SYSTEM	1.225	2.450	0.920	1.740	1.960	3.920
LIVESTOCK WATERING BY RURAL WATER DIST.			1.225	2.450	1.225	2.450
TOTAL RURAL	1.523	3.047	2.637	5.174	3.677	7.354
TOTAL RURAL AND MUNICIPAL	2.925	5.851	4.939	9.777	6.228	12.457
CROP IRRIGATION	3.491	22.754	4.818	31.400	3.185	40.957
SELF SUPPLIED INDUSTRIES						
POWER PLANTS						
COOLING WATER	440.650	518.400	1014.3	1192.0	N.A.	N.A.
OTHER						
OTHER INDUSTRIES						
TOTAL INDUSTRIES						
RECREATIONAL						
TOTAL	447.066	547.005	1024.057	1233.177	9.413	53.414

HARRISON COUNTY

TABLE III - 6

PRESENT AND FUTURE WATER DEMANDS, MGD

MUNICIPALITIES	1973 AVERAGE DAY	1973 MAX. DAY	1995 AVERAGE DAY	1995 MAX. DAY	2020 AVERAGE DAY	2020 MAX. DAY
SERVED BY MUNICIPAL SYSTEM						
RESIDENTIAL						
IN-HOUSE	0.658	0.855				
LAWN IRRIGATION	0.116	0.987				
INDUSTRIAL-COMMERCIAL	0.271	0.406				
TOTAL	1.045	2.248				
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE			0.878	1.141	0.927	1.205
LAWN IRRIGATION			0.155	1.392	0.164	1.463
INDUSTRIAL-COMMERCIAL			0.358	0.537	0.388	0.582
TOTAL			1.391	3.070	1.479	3.250
TOTAL MUNICIPAL	1.045	2.248	1.391	3.070	1.479	3.250
RURAL						
SERVED BY PRIVATE SYSTEM						
RESIDENTIAL						
IN-HOUSE	0.345	0.449				
LAWN IRRIGATION	0.061	0.363				
TOTAL	0.406	0.812				
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE			0.575	0.748	0.575	0.748
LAWN IRRIGATION			0.102	0.606	0.102	0.606
TOTAL			0.677	1.354	0.677	1.354
LIVESTOCK WATERING BY PRIVATE SYSTEM	1.165	2.330	0.875	1.750	1.865	3.730
LIVESTOCK WATERING BY RURAL WATER DIST.			1.165	2.330	1.165	2.330
TOTAL RURAL	1.571	3.142	2.717	5.434	3.707	7.414
TOTAL RURAL AND MUNICIPAL	2.616	5.390	4.108	8.504	5.186	10.664
CROP IRRIGATION	13.732	89.503	18.950	123.514	24.718	161.106
SELF SUPPLIED INDUSTRIES						
POWER PLANTS						
COOLING WATER						
OTHER						
OTHER INDUSTRIES						
TOTAL INDUSTRIES						
RECREATIONAL						
TOTAL	16.348	94.893	23.058	132.018	29.904	171.770

MILLS COUNTY

TABLE III - 7

PRESENT AND FUTURE WATER DEMANDS, MGD

MUNICIPALITIES	1973		1995		2020	
	AVERAGE DAY	MAX. DAY	AVERAGE DAY	MAX. DAY	AVERAGE DAY	MAX. DAY
SERVED BY MUNICIPAL SYSTEM						
RESIDENTIAL						
IN-HOUSE	0.708	0.920				
LAWN IRRIGATION	0.125	0.578				
INDUSTRIAL-COMMERCIAL	0.997	1.496				
TOTAL	1.830	2.994				
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE			1.061	1.379	1.458	1.895
LAWN IRRIGATION			0.188	1.195	0.257	1.549
INDUSTRIAL-COMMERCIAL			2.189	3.284	2.947	4.421
TOTAL			3.438	5.858	4.662	7.865
TOTAL MUNICIPAL	1.830	2.994	3.438	5.858	4.662	7.865
RURAL						
SERVED BY PRIVATE SYSTEM						
RESIDENTIAL						
IN-HOUSE	0.218	0.283				
LAWN IRRIGATION	0.039	0.231				
TOTAL	0.257	0.514				
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE			0.364	0.473	0.364	0.473
LAWN IRRIGATION			0.064	0.383	0.064	0.383
TOTAL			0.428	0.856	0.428	0.856
LIVESTOCK WATERING BY PRIVATE SYSTEM	1.020	2.040	0.765	1.530	1.630	3.260
LIVESTOCK WATERING BY RURAL WATER DIST.			1.020	2.040	1.020	2.040
TOTAL RURAL	1.277	2.554	2.213	4.426	3.078	6.156
TOTAL RURAL AND MUNICIPAL	3.107	5.548	5.651	10.284	7.740	14.021
CROP IRRIGATION	3.171	20.668	4.376	28.522	5.708	37.203
SELF SUPPLIED INDUSTRIES						
POWER PLANTS						
COOLING WATER						
OTHER						
OTHER INDUSTRIES	0.920	1.380	0.920	1.380	0.920	1.380
TOTAL INDUSTRIES	0.920	1.380	0.920	1.380	0.920	1.380
RECREATIONAL						
TOTAL	7.198	27.596	10.947	40.186	14.368	52.604

POTTAWATTAMIE COUNTY

TABLE III - 8

PRESENT AND FUTURE WATER DEMANDS, MGD

	1973		1995		2020	
MUNICIPALITIES	AVERAGE DAY	MAX. DAY	AVERAGE DAY	MAX. DAY	AVERAGE DAY	MAX. DAY
SERVED BY MUNICIPAL SYSTEM						
RESIDENTIAL						
IN-HOUSE	4.622	6.008	6.470	8.411	9.084	11.809
LAWN IRRIGATION	0.815	3.013	1.142	4.938	1.603	6.834
INDUSTRIAL-COMMERCIAL	3.969	5.179	5.704	8.556	8.215	12.323
TOTAL	9.406	14.200	13.316	21.905	18.902	30.966
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE			1.142	1.485	1.306	1.698
LAWN IRRIGATION			0.202	1.155	0.230	1.325
INDUSTRIAL-COMMERCIAL			0.149	0.224	0.171	0.257
TOTAL			1.493	2.864	1.707	3.280
TOTAL MUNICIPAL	9.406	14.200	14.809	24.769	20.609	34.246
RURAL						
SERVED BY PRIVATE SYSTEM						
RESIDENTIAL						
IN-HOUSE	0.696	0.905	0.230	0.299	0.230	0.299
LAWN IRRIGATION	0.123	0.733	0.041	0.243	0.041	0.243
TOTAL	0.819	1.638	0.271	0.542	0.271	0.542
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE			0.914	1.188	0.914	1.188
LAWN IRRIGATION			0.161	0.962	0.161	0.962
TOTAL			1.075	2.150	1.075	2.150
LIVESTOCK WATERING BY PRIVATE SYSTEM	3.350	6.700	2.515	5.030	5.360	10.720
LIVESTOCK WATERING BY RURAL WATER DIST.			3.350	6.700	3.350	6.700
TOTAL RURAL	4.169	8.338	7.211	14.422	10.056	20.112
TOTAL RURAL AND MUNICIPAL	13.575	22.538	22.020	39.191	30.665	54.358
CROP IRRIGATION	3.873	25.244	5.345	34.836	6.971	45.439
SELF SUPPLIED INDUSTRIES						
POWER PLANTS						
COOLING WATER	90.720	116.640	453.0	583.2	N.A.	N.A.
OTHER	0.350	1.440	1.750	7.200	N.A.	N.A.
OTHER INDUSTRIES	1.114	1.671	1.114	1.671	1.114	1.671
TOTAL INDUSTRIES	92.184	119.751	455.864	592.071	1.114	1.671
RECREATIONAL						
TOTAL	109.632	167.533	483.229	666.098	38.750	101.468

TOTAL STUDY AREA

TABLE III - 9

PRESENT AND FUTURE WATER DEMANDS, MGD

	1973		1995		2020	
MUNICIPALITIES	AVERAGE DAY	MAX. DAY	AVERAGE DAY	MAX. DAY	AVERAGE DAY	MAX. DAY
SERVED BY MUNICIPAL SYSTEM						
RESIDENTIAL						
IN-HOUSE	53.459	69.495	89.398	116.216	127.072	165.192
LAWN IRRIGATION	12.572	69.457	21.522	144.402	30.651	210.166
INDUSTRIAL-COMMERCIAL	29.295	50.814	55.376	101.933	71.654	125.197
TOTAL	95.326	189.766	166.296	362.551	229.377	500.555
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE			3.512	4.565	4.155	5.401
LAWN IRRIGATION			.622	4.226	.740	4.873
INDUSTRIAL-COMMERCIAL			2.754	4.133	3.572	5.359
TOTAL			6.888	12.924	8.467	15.633
TOTAL MUNICIPAL	95.326	189.766	173.184	375.475	237.844	516.188
RURAL						
SERVED BY PRIVATE SYSTEM						
RESIDENTIAL						
IN-HOUSE	2.827	3.676	1.262	1.640	.778	1.012
LAWN IRRIGATION	.501	2.980	.224	1.333	.138	.820
TOTAL	3.328	6.657	1.486	2.973	.916	1.832
SERVED BY RURAL WATER DISTRICT						
RESIDENTIAL						
IN-HOUSE			2.815	3.659	2.815	3.659
LAWN IRRIGATION			.497	2.965	.497	2.965
TOTAL			3.312	6.624	3.312	6.624
LIVESTOCK WATERING BY PRIVATE SYSTEM	8.794	17.588	7.875	15.750	15.340	30.680
LIVESTOCK WATERING BY RURAL WATER DIST.			7.525	15.050	7.525	15.050
TOTAL RURAL	12.122	24.245	20.198	40.397	27.093	54.186
TOTAL RURAL AND MUNICIPAL	107.448	214.011	193.382	415.872	264.937	570.374
CROP IRRIGATION	42.042	274.023	58.019	378.152	72.577	493.243
SELF SUPPLIED INDUSTRIES						
POWER PLANTS						
COOLING WATER	1178.567	1567.144	2007.720	2499.944	N.A.	N.A.
OTHER	2.732	4.058	2.36	8.018	N.A.	N.A.
OTHER INDUSTRIES	28.044	42.066	28.044	42.066	28.044	42.066
TOTAL INDUSTRIES	1209.343	1613.268	2038.124	2550.028	28.044	42.066
RECREATIONAL						
TOTAL	1358.833	2101.302	2289.525	3344.052	365.558	1105.683

and 2020. Upstream withdrawals for crop irrigation in two major river basins will affect quantity and quality of water in the Platte and Missouri Rivers reaching the study area.

Electrical Power Generation

The largest single category of water use in the study area is the cooling water required in electric power generation. The six power plant facilities currently located in the study area require an average of about 1.2 billion gallons of water each day for cooling purposes. This is roughly 12 times greater than the total residential, commercial and municipally supplied industrial water requirements in the seven county study area. Approximately 2 MGD is additionally required for such other purposes as boiler water, auxiliary cooling, and miscellaneous plant operations. Only one power plant in the study area obtains primary cooling water from a municipal supply. The small capacity South Omaha Station of OPPD (23 megawatts) purchases its cooling water from MUD for use in a cooling tower. The remaining five facilities utilize the Missouri River as a supply source. For water requirements other than primary cooling, approximately 0.6 MGD is purchased from the MUD system. In Council Bluffs, the Iowa Power and Electric facility is considering the purchase of about .35 MGD from that municipal system. This water is currently supplied by two wells.

Currently announced plans involve phase-out of two power plant facilities and expansion of two others. The Omaha Kramer station (Nebraska Public Power) is scheduled to go out of service by 1995 and will be replaced by a nuclear plant south of the study area. The South Omaha station (Omaha Public Power) is scheduled to be phased out in the near future. See Figure II-4 for power plant locations.

Expansion plans include an 1100 megawatt addition to the nuclear plant at Ft. Calhoun by 1983 and a 720 megawatt fossil fuel addition to the South Council Bluffs station by 1979. Water requirements for these new facilities are indeterminate at this time since it is not yet known whether cooling towers will be used instead of once-through cooling. However, using the current ratio of average day cooling water required to power output capacity, a conservative estimate of 1.4 billion gallons per day is obtained. This yields a total cooling water requirement of 2.5 billion gallons in 1995 for the power generating plants located in the study area.

Although power plant cooling involves a large quantity of water, there is no direct physical linkage with municipal water supply and wastewater systems. Cooling water is returned to the river at essentially the same point that it is withdrawn thereby having minimal effect on river flow. The high estimate for the Ft. Calhoun facility in 1995, however, is about 2000 cfs which is 40%

of the required minimum flow of the Missouri at Omaha.

The primary impact of cooling water is the resultant temperature rise of the receiving body. Temperature differentials across a condenser are typically in the 15 to 18 degree F. range. This elevated temperature results in more evaporation than would otherwise occur. Although consumptive losses may vary greatly, it is estimated that as much as 1% of the water used in a once-through cooling process could be evaporated. This loss would amount to as much as 25 mgd in 1995 based on the above cooling water requirement projection.

Coal Gasification

Another factor in the energy industry which could impact on study area water supply is coal gasification. Several processes exist or are under development which convert coal to gas. The Lurgi pressure gasification process is the most prominent and requires water for process cooling, generation of steam energy, supplying the hydrogen needed to produce the gas, and for various other needs. At least four projects which could require water from the Missouri River are in the planning or proposal stages.

One firm has applied for withdrawal rights of several hundred thousand acre-feet of water per year from the Missouri River at or

near Lake Sakakewca (reservoir of Garrison Dam) in North Dakota. Actual water requirements for the one coal gasification plant scheduled for completion by 1985 would be approximately 10,000 acre-feet per year. Another firm having coal reserves in North Dakota is proposing a similar project, probably in the same area. The impact of coal industry withdrawals from above the mainstem Missouri River dams on study area water interests should be negligible since these dams are used to maintain a minimum flow at Omaha which is well below average Missouri River flow but well above aggregate water requirements.

Two other natural gas companies have coal reserves located in Wyoming. Coal gasification projects of these firms are complicated by a lack of water at the source of coal. Various alternatives are under consideration which include transporting water to the coal reserves or bringing the mined coal to a source of water near the natural gas market area. The market areas for these two firms are the central United States. It is therefore conceivable that coal gasification plants could be located on the Missouri River, in or upstream of the study area. At least one of these firms plans to have a plant in operation by 1982. It is reported that water availability will be a major factor in the location decision for this plant.

A typical coal gasification plant using the Lurgi process requires about 1.4 pounds of raw water intake per pound of coal. This includes water required in mining the coal as well as the gasification process. Current plant designs incorporate maximum recycling and reuse of water. The net water requirement of a typical plant is 8,200 acre-feet per year (2,680 million gallons per year, or 5,100 gpm, or 11.4 cfs).

On an annual basis, the water requirement for a single coal gasification plant amounts to 17.5% of the current crop irrigation water needs in the study area and 7.5% of the amount currently used by all residential, commercial and municipally supplied industrial water users. A single plant located in the area would therefore represent a major user of water. In all likelihood, however, a plant would develop its own water withdrawal facility and hence municipal treatment and distribution would not be involved.

It is significant to note that essentially none of the water used in a coal gasification plant would be directly returned to the supply source. Seventy percent of the net water used is returned to the atmosphere, 10% is converted to hydrogen contained in the gas (eventually returned to the atmosphere as water), and 20% is used in mine reclamation and miscellaneous uses. If all water used by

the plant, including the mining operation, were taken from the Missouri River, the amount taken is not considered to be significant. The 11.4 cfs required by the plant is less than one third of one percent of the 5000 cfs minimum Missouri flow. The 45 year average day flow of the Missouri at Omaha is 28,850 cfs.

Irrigation. Platte River stream flow depletion due to irrigation (and other uses) is a matter of great concern to area water users and is given considerable attention in a later section of this report.

Because of the greater flow regulated by dams, irrigation and other consumptive uses of Missouri River water at upstream locations is less critical to area water needs. The 1969 Missouri Basin Comprehensive Framework Study projects a 45 percent reduction in average annual flow in the Missouri River at Omaha from 1970 to 2020 due to upstream depletion. However, predicted average annual streamflow in 2020 is still in excess of 11 billion gallons per day.

Of perhaps greater concern is the study projection of a Missouri River total dissolved solids (TDS) level of 790 mg/l in 2020, up from 470 mg/l in 1970, compared to the USPHS recommended

drinking water standard of 500 mg/l. Irrigation is a principal factor in TDS increases since part of water withdrawn is consumed via evapotranspiration while the remainder of the flow is returned carrying essentially all of the dissolved solids contained in the total flow withdrawn. Excess flow and leaching are necessary in irrigation to prevent salt build-up in soils to a point where crops are adversely affected. Washout of artifically applied or naturally occurring chemicals in the soil and use of groundwaters high in dissolved solids are also factors affecting stream quality through irrigation return flow.

Increases in magnesium and calcium salts (hardness) will increase treatment costs to maintain a desirable potable water quality. Continued surveillance of other, potentially harmful, constituents will be required to insure public health. A tremendous treatment cost will be incurred should TDS reduction become necessary. It is interesting to note, however, that no TDS limit for drinking water is made by the Environmental Protection Agency's proposed 1974 standards (see Table II-1).

Agricultural. Estimate of future study area livestock water usage is based on increases proportional to those projected in Report on the Framework Study. Irrigated acreage is expected to increase as

predicted in the Lower Platte River Basin Water Quality Management Plan. Irrigation water usage is estimated as one acre-foot per year per irrigated acre.

County-by-county summaries of future agricultural water requirements are given in Tables III-2 through III-9.

EFFECTS OF GROWTH CONCEPTS

Alternative Growth Concepts affect future water quality and quantity requirements in two ways. First, areas of residential, industrial, and commercial development differ among the four concepts, thus altering water demand centers. Second, density of development varies changing the quantities and qualities of water required by the water users.

Land use maps and census tract populations provided by the Corps of Engineers are used to identify regions of water use in the metropolitan area. Residential demand centers are developed wholly on a population basis. For the reasons discussed earlier, general commercial demands are also based on population while heavy commercial and industrial usages are computed on the basis of 2000 gpd per acre of industrial-commercial development. Apportioning of industrial demands to areas was accomplished with the aid of the aforementioned land use maps.

To determine effect of housing density on water requirements, a detailed analysis of new housing density was performed by HDR in conjunction with the Corps of Engineers. New residential growth from the present to 1995 and from 1995 to 2020 was examined by Housing Study Area for each growth alternative and estimates of the division of new housing among high medium and low density groupings made. Population densities assumed in each of the three groupings in terms of people per acre of residential development are given in Table III-10.

TABLE III-10

RELATIVE POPULATION DENSITIES

Grouping	Population Density (People/residential acre)
Low	Less than 7
Medium	7 to 18
High	More than 18

Portions of new growth assigned to each density grouping are listed by growth alternative in Table III-11.

TABLE III-11

NEW RESIDENTIAL DEVELOPMENT DENSITY

Growth	Relative Density Year	L	M (Percentage)	H
A	1995	43	36	21
	2020	43	37	20
B	1995	22	35	43
	2020	15	38	47
C	1995	17	31	52
	2020	15	36	49
D	1995	37	39	24
	2020	42	38	20

Literature data, primarily a study by the John Hopkins University, and Metropolitan Utilities District and Council Bluffs Water Works records and reports were evaluated to determine water usage differences due to development density. Evaluations indicate that water usage patterns and quantities projected by the MUD report correspond very closely to an average medium density development. It was also determined that differences in development density water requirements are almost wholly due to out-of-house usage and that residents of low density developments will use 7.2 gpd per capita more and residents of high density developments 9.0 gpd per capita less than medium density housing residents.

Per capita residential and general commercial usages and maximum day and maximum hour factors were computed and are

evaluated and summarized hereafter. Development density effect on general commercial water usage is assumed to be proportional to that on residential usage because of similarities between MUD residential and general commercial class users detailed in Section II. Table III-12 summarizes housing density effect on everage day consumption, and maximum day and maximum hour load factors for residential (and/or general commercial) new growth only. New development from the present to 1995 only is shown since 1995 to 2020 development density is similar.

TABLE III-12

CHANGE IN MUD FACTORS DUE TO HOUSING DENSITY

Growth	Factor (Percent change from MUD Projections) Average Day Usage	Maximum Day Load Factor	Maximum Hour Load Factor
A	+ 0.7	+ 3.2	+ 3.6
B	- 3.2	- 6.1	- 7.3
C	- 4.8	- 8.9	- 10.4
D	+ 0.7	+ 1.2	+ 1.6

Again, it must be emphasized that while differences in factors tabulated in Table III-12 are significant, they apply to new residential

and commercial growth only. System-wide differences between growth alternatives A and C in 1995 are only about one percent on a per capita daily consumption basis.

Future metropolitan area water requirements are summarized in Tables III-13 through III-16 for eight metropolitan Omaha and four metropolitan Council Bluffs water use areas. Industrial water requirements for Growth Concepts A, C and D are from MUD and Council Bluffs water system master plans with location of industrial usage adjusted for each Concept according to land use maps provided by the Corps of Engineers. Industrial usage for Concept B is reduced in the metropolitan area by the amount of increase in industrial water consumption in the satellite cities. Quality requirements for industrial users is summarized in Section II and potentials for industrial water user reduction in Section IV.

Water requirements for satellite cities and new towns of Concept B are listed in Tables III-17 and III-18. Residential consumption in Concepts A, C and D is based on projections as summarized in Appendix 1, Section B. Residential consumption in Concept B is computed using per capita consumption rates of 129 and 154 gpcd

for 1995 and 2020 respectively. Satellite city industrial water need for all Concepts is taken from the Regional Wastewater Management Study, Phase 1, Volume III by Havens and Emerson, Ltd.

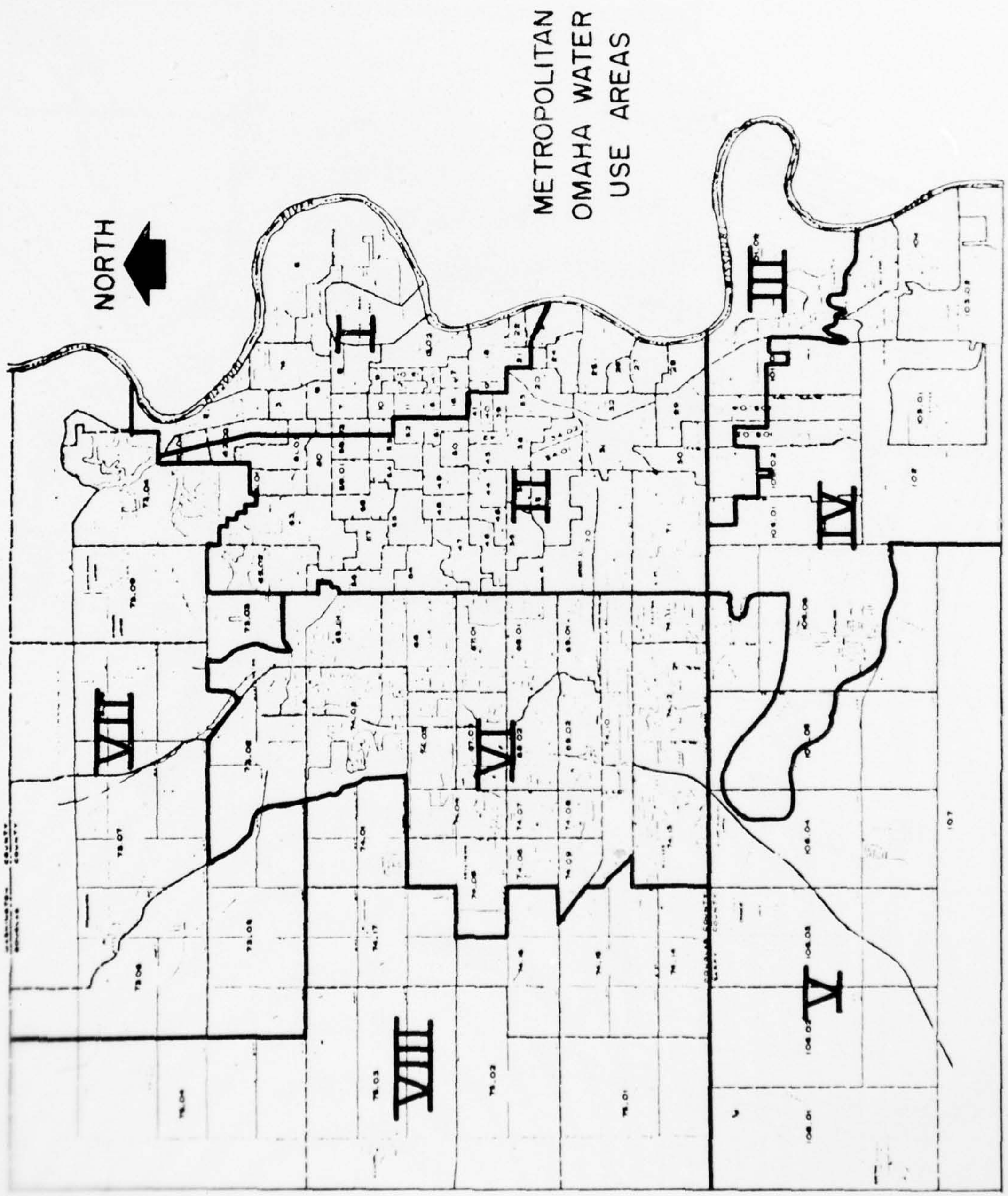
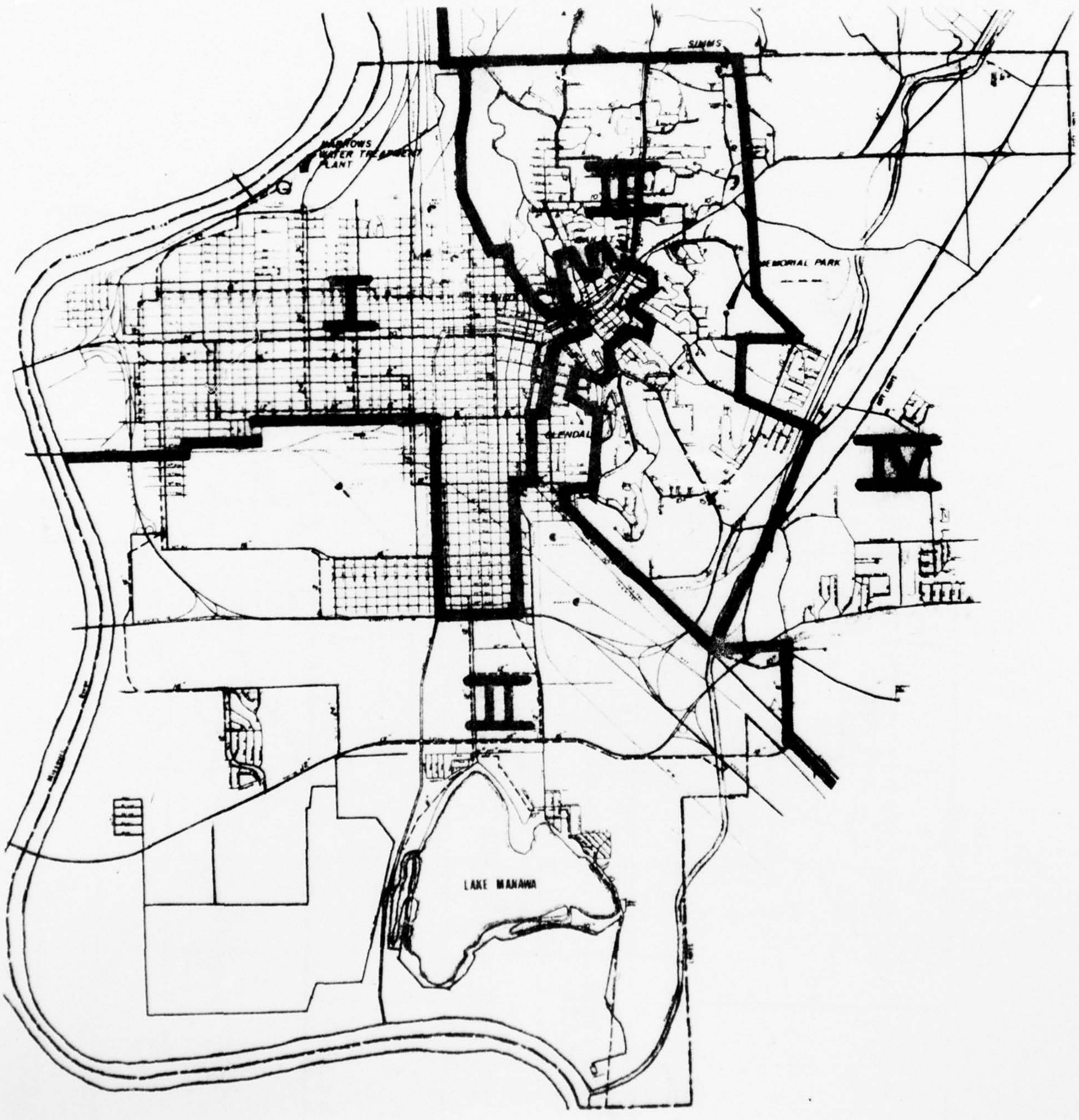

METROPOLITAN
OMAHA WATER
USE AREAS
NORTH
I
II
III
IV
V
VI
VII
VIII

FIGURE III - 2



METROPOLITAN COUNCIL BLUFFS
WATER USE AREA

FIGURE III - 3

TABLE III-13
METROPOLITAN AREA AVERAGE DAY
WATER REQUIREMENTS
(in mgd)

1995

WATER USE AREA	A	B	C	D
MUD				
1	29.8	31.2	34.6	30.1
2	39.9	39.2	45.9	39.8
3	5.9	5.7	7.6	5.8
4	20.2	9.9	14.9	19.7
5	12.3	5.2	8.0	14.5
6	31.6	31.4	34.8	32.2
7	6.0	4.7	3.6	5.1
8	5.6	1.1	2.1	4.9
C.B.				
1	6.6	6.6	6.6	6.4
2	2.3	2.8	2.3	2.3
3	1.5	1.5	1.9	1.5
4	1.3	0.8	0.8	1.5
SUBTOTAL	163.0	140.1	163.1	163.7
REMAINDER METRO AREA	5.6	16.9	3.3	4.5
TOTAL	168.6	157.0	166.4	168.2

TABLE III-14
METROPOLITAN AREA MAXIMUM DAY
WATER REQUIREMENTS
(in mgd)
1995

GROWTH AREA	A	B	C	D
MUD				
1	54.2	56.9	63.5	54.8
2	92.8	91.4	106.5	92.6
3	14.4	13.4	17.7	14.0
4	47.3	23.6	34.0	46.5
5	27.7	12.0	17.4	32.7
6	74.7	73.2	80.6	75.8
7	13.8	10.8	7.9	11.4
8	13.6	2.8	5.0	11.8
C.B.				
1	9.2	9.2	9.3	8.7
2	3.5	4.6	3.5	3.4
3	3.4	3.4	4.2	3.4
4	3.1	1.8	1.8	3.5
SUBTOTAL	357.7	303.1	351.4	358.6
REMAINDER METRO AREA	12.4	31.1	6.9	10.0
TOTAL	370.1	334.2	358.3	368.6

TABLE III-15
METROPOLITAN AREA AVERAGE DAY
WATER REQUIREMENTS
(in mgd)
2020

GROWTH AREA	A	B	C	D
MUD 1	35.1	38.3	39.8	35.0
2	48.2	52.7	55.8	48.0
3	8.3	9.8	10.3	7.6
4	25.7	13.3	22.4	24.9
5	23.4	7.2	15.8	28.4
6	45.0	48.6	54.3	44.7
7	10.7	7.9	7.6	10.4
8	18.1	1.3	4.2	14.8
CB				
1	7.9	7.6	8.2	7.8
2	3.7	3.5	3.2	4.0
3	1.9	1.9	2.5	1.9
4	2.6	0.9	1.5	3.1
SUBTOTAL	230.6	189.5	225.6	230.4
REMAINDER METRO AREA	5.5	25.1	5.2	5.0
TOTAL	236.1	214.6	230.8	235.4

TABLE III-16
METROPOLITAN AREA MAXIMUM DAY
WATER REQUIREMENTS
(in mgd)
2020

GROWTH AREA	A	B	C	D
MUD				
1	64.2	70.4	73.3	64.0
2	110.4	121.5	127.7	110.0
3	19.4	22.5	23.1	17.8
4	59.1	30.8	50.1	57.3
5	54.7	16.4	34.7	66.0
6	104.6	110.8	123.5	103.4
7	24.5	17.6	16.7	23.5
8	44.1	3.2	9.8	35.4
C.B.				
1	11.3	10.8	12.0	10.9
2	6.2	5.8	4.9	6.6
3	4.3	4.3	5.5	4.4
4	6.1	2.0	3.4	7.2
SUBTOTAL	509.0	416.2	484.7	506.5
REMAINDER METRO AREA	11.0	46.4	9.5	10.0
TOTAL	520.0	462.6	494.2	516.5

TABLE III-17

SATELLITE CITY AVERAGE

DAY WATER REQUIREMENTS

(in mgd)

1995

	A, C & D			B		
	Residential[1]	Industrial[2]	Total	Residential[1]	Industrial[2]	Total
Blair	1.66	0.76	2.42	3.09	1.95	5.04
Ft. Calhoun	0.18	0.11	0.29	0.77	0.49	1.26
Missouri Valley	0.31	0.32	0.63	1.29	0.81	2.10
Glenwood	0.84	0.33	1.17	1.29	0.81	2.10
Plattsmouth	0.85	0.62	1.57	2.58	1.63	4.21
Springfield	0.46	0.06	0.52	2.58	1.63	4.21
Gretna	0.89	0.34	1.23	3.22	2.03	5.25
Elkhorn	0.37	0.10	0.47	1.93	1.22	3.15
Valley	0.31	0.21	0.52	0.64	0.41	1.05
Bennington	0.45	0.09	0.54	1.93	1.22	3.15
NEW CITIES						
Florence Precinct				0.26		0.26
Deer Creek				0.64		0.64
East Bellevue				0.92		0.92

SOURCE: 1 HDR

2 Regional Wastewater Management Study.

Phase I, Havens and Emerson, Ltd.

TABLE III-18
SATELLITE CITY AVERAGE
DAY WATER REQUIREMENTS
(in mgd)
2020

	A, C & D			B		
	1 Residential	2 Industrial	Total	1 Residential	2 Industrial	Total
Blair	1.84	0.84	2.68	4.61	2.44	7.05
Ft. Calhoun	0.23	0.14	0.37	1.23	0.65	1.88
Missouri Valley	0.34	0.35	0.69	1.54	0.81	2.35
Glenwood	1.29	0.29	1.58	1.54	0.81	2.35
Plattsmouth	0.89	0.65	1.54	3.08	1.63	4.71
Springfield	0.86	0.15	1.01	3.84	2.03	5.87
Gretna	1.60	0.28	1.88	5.38	2.84	8.22
Elkhorn	0.46	0.20	0.66	3.00	1.83	4.83
Valley	0.48	0.27	0.75	0.92	0.49	1.41
Bennington	0.59	0.12	0.71	3.00	1.83	4.83
NEW CITIES						
Florence Precinct				0.31		0.31
Deer Creek				1.08		1.08
East Bellevue				1.08		1.08

SOURCE: 1 HDR
2 Regional Wastewater Management Study, Phase I, Havens and Emerson, Ltd.

SECTION IV

WATER USE REDUCTION

SECTION IV

WATER USE REDUCTION

Unlike certain areas of the United States, the forecasted water requirements in the seven-county study area do not critically approach available supplies. For example, a previous study for the Omaha Metropolitan Utilities District estimated that the potential exists for obtaining 668 mgd from a single new source alone near Eppley Airfield.

Apparent "unlimited" supplies no longer preclude serious consideration of water conservation, however. Past exploitation of our nation's natural resources has taught us, sometimes painfully, to have a more precious regard for their existence. In addition, supply is not the sole factor of concern. The economic effect of deferred system expansion and development must also be considered. Even if the supply of water itself does not become critical in the study area, the resource availability of labor, capital and materials to develop such new supplies may become so.

The purpose of this section, then, is to inspect various concepts for reducing water use. The primary concern deals with the use of potable water since this is generally the most expensive to supply; a secondary concern is total use of water.

The first sub-section below summarizes categories of water use helping to focus use-reduction concepts toward those areas where the most significant and/or achievable effects can be produced. The second section presents various alternative concepts, both structural and non-structural. The third section details a wide range of dual-supply and reuse concepts in residential water use and the last section presents a chart-matrix comparing the various use-reduction concepts by such factors as potential quantity reduction, required investment, dependence on future technology, and public acceptability.

SUMMARY OF WATER USER CATEGORIES

As presented earlier in this study, the seven-county region (dominated by the metropolitan area) has historically shown a continual total system and per capita increase in water use. Total increase is most easily explained by general population and economic growth.

Analysis of per capita use is more complex involving such things as higher standards of living and associated life-style changes, rapid development of consumer-oriented technology, and the relative health of local water-using industry. Additional complexity is arising from shifts in water use by both category and geographic location. For example, the rapid growth of female employment on a career basis is shifting water use out of the home and into places of employment and restaurants. Geographical areas which once may have involved crop irrigation now see

heavy residential water use. And whereas commercial, office and light industry land uses used to be highly concentrated at the city core, they have now taken on a decentralized pattern.

The future range of water quantity requirements presented earlier relative to the four alternative growth concepts incorporate a consideration of various land use and development patterns. What remains is to inspect the specific water user categories with respect to possible concepts for water use reduction.

Residential

Residential water customers currently require, as a group, the largest share of water from public supplies in the study area. Roughly 40 percent of Council Bluffs and MUD supplied water goes to residential category users; in smaller towns in the study area this share is as high as 90 percent. In addition, the residential category involves the greatest proportion of water customers. For example, in the MUD system, residential customers numbered approximately 90,000 in 1973, accounting for 87% of the system's customers.

Furthermore, residential customers represent a very homogeneous group. Although economic status and net dwelling unit densities do contribute variability, analysis of a "typical" household can yield potential applicability to essentially all households. These factors dictate that the residential user category should have highest priority for inspection.

Industrial

The industrial water customer category also ranks high for potential water use reduction analysis. Although annual industrial water use is roughly one half of residential, industry accounts for a very small proportion of total customers. Hence average use per customer is quite high. For example, in 1973, less than 1% of MUD's customers were classified as industrial yet they accounted for about 23% of total water use. Ten of these customers were responsible for nearly 13% of the total system water use. Even with great variability among customers, the small number of high quantity users affords the opportunity for individual customer analysis.

Commercial

The commercial customer category ranks second to residential in quantity used, accounting for roughly 30% of the total, and also second in number of customers (12,000 of MUD's customers are in the commercial category representing 13% of the total). The wide divergence of users, however, adds complexity to the analysis of this category. As discussed in Section II, a sub-category classified general commercial is assumed to have water use characteristics similar to residential users and is combined with this category for purpose of water use reduction analysis.

WATER-USE REDUCTION CONCEPTS

Various techniques and approaches for achieving reductions in water use are presented below in two major categories, structural and non-structural. Structural approaches are those which involve mechanical

devices, facilities, pipe, etc. (i.e., "hardware" approaches); non-structural ideas involve such things as water prices and laws.

For purposes of conceptual planning, current feasibility and practicality has not been used as a factor to screen out consideration of possible approaches for reducing water use. Technology is accelerating at such a great rate that it precludes making accurate assessments of the realities of the 25 and 50 year futures. Similarly, attitudes are also changing rapidly. Where possible, however, comments regarding public acceptability and technical feasibility are provided based on existing standards and trends.

Where possible, potential water quantity savings are presented in terms of percent reduction of existing conditions or, as the case may be, of projections based on existing conditions. Percentages are then converted to quantity reductions based on the applicable population or customer group involved.

NON-STRUCTURAL ALTERNATIVES

Voluntary Action

One of the least complex, costly and controversial alternatives for achieving a reduction in water use is through voluntary action on behalf of the users of water. This voluntary action may result in general

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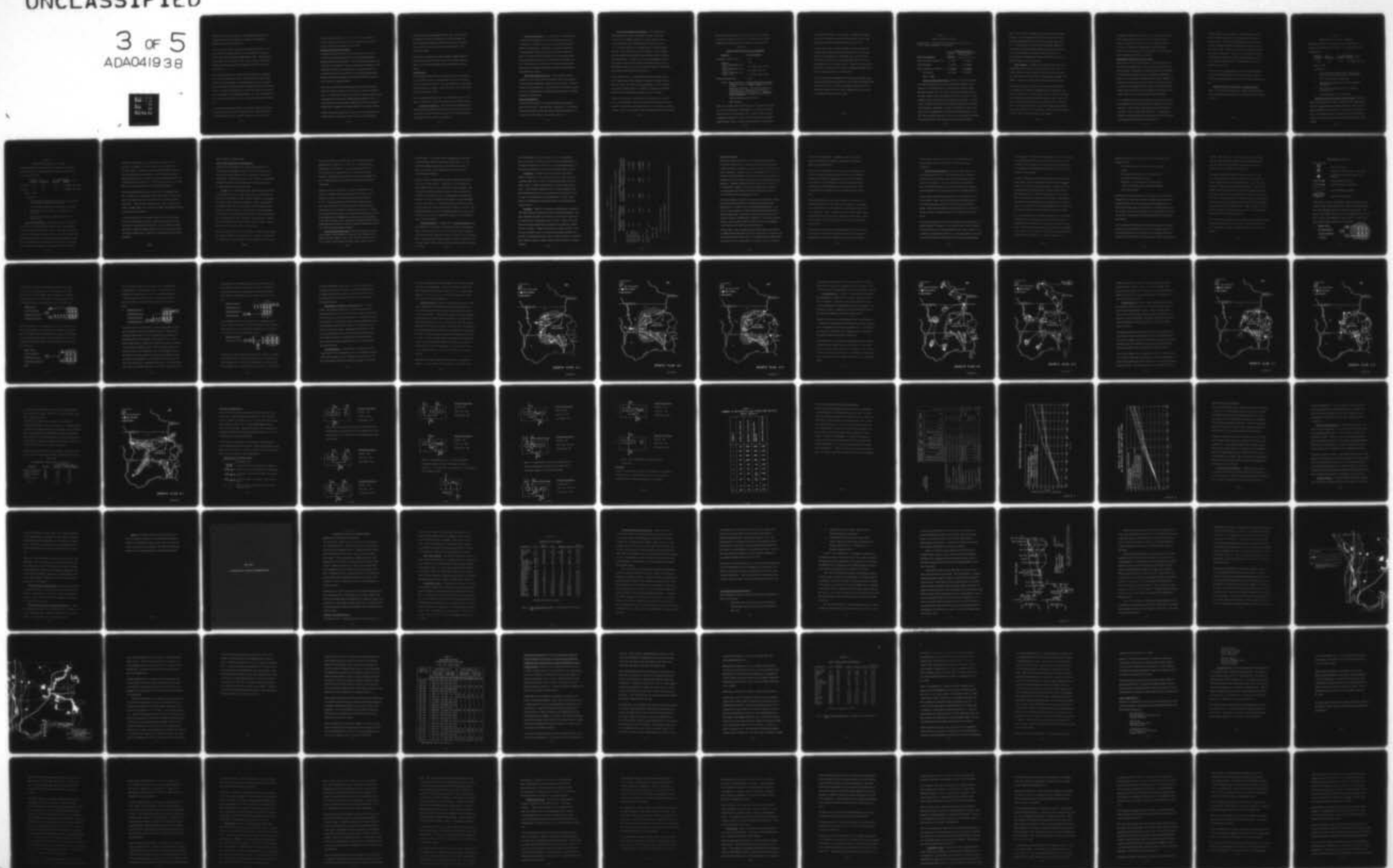
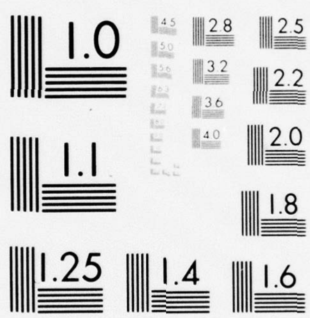




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

attitudes toward conservation, life-style changes which reduce or eliminate certain water demands, or simply the elimination of wasteful and unnecessary water use.

Voluntary action will not come about spontaneously, however. Except in the face of highly apparent critical conditions, the general public usually will not employ mitigating measures. When mass action is taken, it is often short lived. A case in point is the energy shortage situation which the United States has faced over the last several years.

Water system administrators and others must therefore implement well-conceived programs of public education if water conservation attitudes are to be adopted. An essential aspect of such a program will be an honest presentation of facts, potential benefits and achieved results. Of especial importance is the assurance that no one element of the community is unjustifiably exempted. If a program becomes viable, public pressure itself can serve to spread and perpetuate compliance.

It is difficult to quantify potential water demand reductions resulting solely from voluntary actions. Although a water conservation-public education program can be a singular attempt to reduce water use,

greatest potential benefits can be derived if such a program is used in conjunction with, and to gain acceptability for, the other possible alternatives presented in this report.

Industrial Development Promotion

Continued expansion of the seven-county study area's economic base will be an essential ingredient in achieving the population growth which has been projected. Just as future water systems and land uses can be planned, so also can industrial development. Those individuals, agencies and organizations seeking to promote local economic growth must be cognizant of the potential demands and impacts which various industries and particular firms can have on local resources, especially water.

The various incentives and inducements which exist (by design or otherwise) should be inspected for the types of industry which they attract. In particular is the current water pricing policy which serves to subsidize the cost of water to high quantity industrial users. If equally desirable, but low water using industries can be attracted through other techniques, this policy should receive close scrutiny.

If future industrial growth were to require water at half the rate of existing industry, the expected total increase in water demands

could be reduced by approximately 14 percent. This goal could probably be realized by promoting increased development of fabricating and assembly type industries with lesser emphasis on food and other agriculture products which require large quantities of water.

The 50 percent reduction in water demands for new industrial growth in the study area would result in a decrease of about 12 mgd, in 1995, from the amount which would otherwise be expected.

Legal Actions

Various legal actions may come into play in the course of achieving a reduction in water use through one or more of the alternatives discussed in this report. For some alternatives, legal action may be necessary; in others, such action may be desirable to help achieve the intended results.

Several legislative alternatives are presented below in three categories: permissive, restrictive and tax incentives/disincentives.

Permissive legislation. This would involve modifying local building codes and state health and water quality laws to permit recycled water and dual system concepts as well as other innovative technology such as non-water using toilets.

Restrictive legislation. On a local scale, such laws could 1) require the installation of water conserving devices in new construction, 2) prohibit local sales of excessive water-using fixtures and appliances, 3) prohibit or control the expansion or new development of industry which uses excessive amounts of water, 4) require the use of available water conserving technology in industrial processes, and 5) provide for rationing of water. On a national scale, laws could be enacted to prohibit the manufacture of fixtures and appliances which use unnecessarily large quantities of water.

Tax Incentives/Disincentives. As an incentive, tax exemptions or tax credits could be allowed for the use and purchase of water conserving fixtures, appliances and processes. As a disincentive, the purchase,use or installation of certain water using devices (e.g. swimming pools, disbursing machines and car washing machines) could be taxed.

Water Pricing Policy

A water price increase is a potential method for effectuating a water-use reduction. Like with other commodities, a relationship exists between the price of water and the quantity demanded; an increase in price resulting in a decrease in water use.

Water Price-Demand Relationships. The mathematical relationship between price and demand is called "elasticity" (ratio of percent change in quantity to percent change in price). In some instances, this relationship may be totally inelastic, i.e., no matter what the price change may be, demand remains constant. This would be the case, for example, with an industry which has specific water quantity requirements related to a manufacturing process. If water costs were not insignificant, however, a water price increase could provide sufficient incentive to alter production volumes or the water-using process itself. In this case, the inelastic situation would be short-term.

On the other extreme, a relationship that is fairly elastic will result in significant quantity changes in response to changes in price. The use of water for exterior cleaning purposes or for lawn watering in areas of high rainfall are examples of situations in which the quantity used could be highly responsive to a price change.

Empirical studies have resulted in the derivation of price elasticities for water demand. Because of their different demand functions, domestic (in-house) and sprinkling water use are considered separately. Likewise, it has been recognized that sprinkling demand differs greatly

between the eastern and western sections of the U. S. because of variations in annual rainfall. Price elasticities for various components of water demand are summarized in Table IV-1

Table IV-1

WATER PRICE/DEMAND RELATIONSHIPS*

Water use	Price elasticity
Residential, central U. S.**	-.17
domestic	-0.10
summer sprinkling, eastern U. S.	-1.57 (max. day: -1.25)
summer sprinkling, western U. S.	-0.70 (max. day: 0)
summer sprinkling, central U. S.**	-1.15 (max. day: -0.80)
Commercial/Industrial	-0.10

Source: Hanke and Davis, "Demand Management Through Responsive Pricing," AWWA Journal, Sept. 1971, P. 555.
Howe and Linaweaver, "The impact of Price on Residential Water Demand and Its Relation to System Design and Price Structure," Water Resources Research, First Quarter 1967, P. 13.

* Metered systems on public sewer.

** HDR estimate.

Table IV-1 indicates that a 10% water price increase would result in a 1% drop in domestic usage (likewise, a 10% price reduction would result in a 1% increase in use). A water bill for a typical residential customer is so small relative to the entire household budget though, that the customer would probably be unresponsive

to small price increases. For example, in Omaha, residential water use currently costs less than 4¢ per person per day, supporting the generally accepted notion that water is "free."

In 1968, water prices in Council Bluffs were increased by 25%. Although water demand did drop immediately after the increase, quantities in following years rebounded to pre-increase levels. The short-term decrease in use may therefore have been due to psychological and not economic factors. Water prices would probably have to increase by 50% or more if long-term quantity reductions in residential water use were desired.

A new rate structure adopted by the City of Council Bluffs in late 1974 increases block rates from 30 to 50 percent and minimum bills from 30 to 36 percent. Future consumption records for Council Bluffs will indicate the effect of this substantial rate increase on residential and industrial water usage.

Table IV-2

PRICE INCREASE EFFECT

Potential Water Use Reduction Resulting From a 50% Price Increase, Municipal Supplies, Average Day

	Quantity Reductions	
Water Use Category	Based on current water use	Based on projected 1995 water use
domestic-general commercial	2.7 MGD	4.6 MGD
lawn sprinkling	7.2 MGD	12.5 MGD
other commercial/ industrial	1.5 MGD	2.9 MGD
Total Above	11.4 MGD	20.0 MGD

Source: HDR

Basis for setting Water Rates. Water rates in the study area follow the traditional practice of 1) uniform rate schedule for all categories of customers and 2) decreasing block rates for larger quantities of water used. The lower rate to large quantity users encourages wasteful use since marginal cost to the consumer of using additional water actually decreases rather than increases. Because of this, industrial water costs are partially subsidized by non-industrial customers. Similarly, customers contributing to peak period water use are subsidized by non-peak contributing customers, e.g. the urban city dweller with little or no lawn to irrigate helps subsidize the suburban dweller with extensive lawn sprinkling demands.

Since a water system is designed on maximum day and peak hour demands, it may be appropriate that the customers who create the peak demand should bear the cost of providing excess capacity. Rate schedules structured on this philosophy might then lead to peak season price differentials and increasing unit costs (or at least constant) for increased volumes of water used. Price/demand relationships discussed above would be more responsive under such a rate structure.

Sewer Charges. Charges for residential sewer service in Omaha and Council Bluffs are based directly on water use. In Council Bluffs, the sewer charge is 56% of the water bill during the winter months and 40% of the bill during summer months. In Omaha, a base sewer charge is derived from winter water use.

Since sewer charges are tied directly to water use and in fact, are included in the same bill (although itemized separately) and since it is difficult to "see" the sewer service rendered, most customers probably consider the combined charges as their "water" bill. Also, because the sewer charge is an attempt to reflect domestic water use, the sewer charge is a lower percentage of the summertime water bill than it is of a winter bill. This results in an apparent, yet false, lower unit cost of water in the summer.

This apparent differential in water rates certainly does not tend to discourage summer water use and in fact may encourage greater use than would otherwise occur. If water pricing is to be used as a technique to manage peak demands and effect overall water use reduction, billing for sewer service should be kept as separate and distinct as possible.

Introduction of Meters in Flat-Rate Areas

When water is sold on a flat rate basis, average use per customer tends to be higher than if it was metered and billed in relation to quantity. Furthermore, installation of meters in existing flat rate areas has shown to result in permanent reductions in water use. For example, detailed water-use data in Boulder, Colorado for the five years before and after the introduction of metered sales in residential areas revealed a 36% drop in average domestic use and a 50% drop in sprinkling use; the drop was persistent, there was no recovery to pre-metered quantities.

It is estimated that less than one half of one percent of the study area population is served by public water supplies sold on a flat rate basis. Of the several communities which do not have metered sales, none is larger than 400 people. It would appear, therefore, that this method of achieving reduced water use would have marginal potential effect in the study area.

Further analysis reveals, however, that many people living within a metered system are in effect paying for water on a flat-rate basis. Recent trends in apartment construction have resulted in multiple numbers of housing units being served by one master meter. Similarly, in mobile home parks one meter often serves many units. In such cases, average water use is computed into a monthly rent charge and the individual is unaware of both how much water he is using and how much he is paying for such service.

There are currently approximately 55,000 occupied apartment units and 3,400 mobile homes in the study area for a total of 58,400 units which potentially could be serviced from master meters.

Potential Water-Use Reduction - Existing Population. Table IV-3 indicates potential water savings resulting from the individual metering of dwelling units currently served from a master meter.

Table IV-3

MASTER METER EFFECT - EXISTING

Potential Reduction in Average Annual Water Requirements Resulting from the Elimination of Master Meter Hook-ups; Existing population.

domestic (in-house)	total residential	total system percent	total system actual
4.5%	3.6%	1.4%	1.33 MGD, Avg. Day

Source: HDR

Assumptions:

1. 25% reduction in domestic water use (per unit involved) resulting from individual unit metering.
2. 60% of 58,400 units are applicable.
3. Applicable units comprise 18% of total number of dwelling units.
4. 80% of total residential water is for domestic (in-house) use.
5. 40% of total water use is residential.

Potential Water-Use Reduction -Future Growth. Table IV-4 indicates potential water savings resulting from the individual metering of all new dwelling units which would have been on master meter assuming the continuation of current trends. Concepts "A" and "C" are presented since they represent the low and high extremes, respectively, of proportion of new dwelling units at high density.

Table IV-4

MASTER METER EFFECT - FUTURE

Maximum Potential Reduction in Average Annual Water Requirements resulting from the elimination of master meter hook-ups; new Population Growth.

	domestic (in-house)	total residential	total system Percent	total system Actual
Concept A	3.9%	3.2%	1.3%	2.23 MGD, Avg. Day
Concept C	9.8%	7.8%	3.1%	5.32 MGD, Avg. Day

Source: HDR

Assumptions:

1. 25% reduction in domestic water use (per unit involved) resulting from individual unit metering.
2. 75% of additional high density population is applicable.
3. 80% of total residential water is for domestic (in-house) use.
4. 21% of A future growth is high density; 52% of C is high density.

Cost of Implementation. Individual unit meter and installation costs are approximately \$100; master meter and installation costs are approximately \$150 per meter. Assuming zero salvage value for existing master meters, the cost per unit to convert existing housing from master to individual metering is therefore about \$100. Assuming a ratio of 8 units per master meter, the cost per unit of individual metering new construction would be about \$80.

Using an average domestic per capita water use rate of 55 gal per day, an average of 3.0 persons per unit, and MUD's current water prices, a typical residential water bill would be $41.00 per year (excluding lawn sprinkling). A 25% reduction in annual water use would result in an annual savings of approximately $10.00. Assuming a discount rate of 8%, it would take 14 years to recover the $80 per unit initial investment to install individual meters.

Since the multiple dwelling unit meters would record higher quantities, and hence take "advantage" of lower block rates. the allocated water rates would tend to be lower than if each unit were metered separately. With individual metering, then, water revenues would tend to be higher while at the same time a higher per household charge would tend to reduce demand.

It must be noted that use reductions would not occur for the apartment and mobile home units which currently use quantities of water which fall into the minimum bill bracket. In fact, individual metering of these customers might actually result in a water use increase. Currently available data is insufficient to determine the extent of this possibility.

STRUCTURAL ALTERNATIVES

Water Conserving Fixtures and Appliances

Significant water savings can be achieved through the use of certain fixtures and appliances which reduce or eliminate water requirements when compared to their traditional water-using counterparts. Introduction of these devices could be accomplished through the replacement or modification of existing fixtures or through installation in new construction.

Toilets. It is estimated that toilet flushing accounts for 40% of the in-home water use. Most of the toilets currently in use require up to 8.0 gallons per flush, with the standard, or most popularly used, model requiring 5.25 gallons. Water-saving models currently available use 3.25 gallons per flush and adequately perform their required function. Use of the water-conserving model instead of the standard model would therefore reduce toilet flushing water requirements by 38%, resulting in an annual water saving of about 14,000 gallons for a typical family of four persons. Total in-home water use would be reduced by 15 percent.

Non-water using toilets have been available for years, most of which use chemical additives for decomposition. Although used primarily for construction sites and temporary crowd gatherings such as fairs,

local representatives do indicate that sales are made to private individuals for residential use. The cost of a chemical-action, portable toilet is about $170. Local ordinances would need to be reviewed prior to implementation of such a water-saving technique. The building code applicable to the City of Omaha does not currently authorize the permanent installation of non-water using toilets.

Another version of a non-water using toilet, called the "clivus multrom," employs biological decomposition of wastes. This fixture is currently in very limited production and sells for $1,300. Volume production would probably greatly lower the price since the fixture consists primarily of a large fiberglass tank and involves no moving or energy converting devices. Toilets are available which use gas or electrically fired incineration or chemical additives for decomposition. These non-water using toilets would reduce in-home water requirements by approximately 40% and would also have the attractive feature of greatly reducing the generation of wastes for municipal treatment.

Flow reduction shower heads. Where running water is used and its capture is not desired or required, water savings can be achieved by governing the rate of flow. Much of the water used under "running" conditions goes down the drain, having served no

useful purpose. In the home, these situations apply primarily to hand washing, showers and manual dish rinsing. It is estimated that bathing and personal use of water accounts for 35 percent of in-home water requirements, 60 percent of this category going to showers.

Devices which can modify shower heads to reduce water flow by 50% are currently available. Additional cost to install flow reducing shower heads in new construction would be minimal. Cost of replacing conventional shower heads in existing construction would be less than $10 per unit. Assuming that most people take showers at or close to maximum flow and that with the installation of a flow reducing device, duration of showers would not increase, in-home water use could be reduced by as much as 10 percent. Depending upon shower duration, substantial quantities of water could be saved by use of the 2 to 4 gpm flow through a restricted shower nozzle versus a tub bath.

Washing Machines. In August 1969, Consumer Reports magazine published technical data on 14 different models of washing machines. The average water use, per 8 lb. load, of these machines was 46 gallons with a range from 32 gal. to 59 gal. Use of the lowest water requirement model would result in a 39% water saving over the "average" model. This savings would yield a total in-house reduction of 6 percent.

Future technology could significantly reduce or even eliminate the use of water for cleaning purposes through such innovations as ultrasonics/hydrasonics ("shake" dirt loose from high frequency vibrations) and expansion of the use-once-and-throw-away concept.

Incentives. An analysis conducted by Howe and Vaughn (AWWA Journal, Feb. 72) concluded that unless water rates were extremely high, there is little or no financial incentive to the consumer to buy or replace existing fixtures with those that conserve water. Achievement of significant water savings through this method would therefore have to come about from wide-spread concern for water conservation by the consuming public or from a major shift in the manufacture of applicable fixtures toward designs that conserve water.

Summary. Table IV-5 summarizes potential water savings in 1995 which could be achieved by the above discussed techniques. The water quantities indicated by the table are conservative in that they are based solely on residential water use rates. Water conserving fixtures also have applicability in the general commercial category of water customer. Unlike the residential category, however, commercial customers form a very heterogeneous group making it impossible to estimate the number and use rates of the fixtures discussed above without a special, indepth analysis of the commercial customer category.

Table IV-5

WATER CONSERVING DEVICE EFFECT

Potential 1995 Water Savings from use of Water Conserving Fixtures and Appliances

	Per applicable Housing Unit		Total Study Area Reduction		
	% reduction per category	% in-house reduction	% reduction total residential	% reduction total water use	actual reduction total water use
water conserving toilet	38%	15%	5.0%	1.9%	3.26 MGD
flow reduction shower head	50%	10%	3.4%	1.3%	2.23 MGD
water conserving washing machine	39%	6%	2.0%	0.8%	1.37 MGD
Total above		31%	10.4%	4.0%	6.86 MGD
non-water using toilet	100%	40%	13.4%	5.1%	8.76 MGD

Source: HDR

Assumptions:

1. residential use is 40% of total.
2. in-house use is 80% of residential.
3. applicable base is 25% of existing housing stock plus 75% of new housing units.

Dual Water Systems

Dual water systems can potentially yield the greatest reduction in demand for pure water yet probably involve the largest number of legal and public acceptability hurdles of all the use-reduction concepts considered. Of great concern is the possibility of cross-connections and the subsequent use of non-potable water for human consumption or use in an industrial process that is highly water-quality dependent. Adequate safeguards would therefore be necessary. It is also possible, however, that the non-potable water could be of such high quality that inadvertent mixing would cause no harm even if undetected for a long period of time.

The basic purpose of a dual water system is the separation of water into two distribution channels, one directed to uses requiring potable water, the other to uses not requiring potable water. Except for crop irrigation, several small towns and possibly some industrial applications, essentially all water used in the study area has been treated to drinking water standards. It has been estimated, however, that as little as 10% of the water used in a metropolitan area requires such a high degree of purification.

Theoretically, then, the Omaha-Council Bluffs region could expand by 1000% without added water purification capacity if a secondary supply and distribution system were to be comprehensively implemented. Practically, the cost of providing a secondary system in developed

areas would be prohibitive. Additionally, public acceptance could be a constraint on complete substitution of non-potable water for non-potable uses.

In new and redevelopment areas, hoever, the cost-effectiveness of such a concept could be favorable and warrants investigation. This would be especially appropriate for areas which would involve extensive new development at medium and high densities, affording an excellent opportunity to mesh water resource planning and land use planning to achieve mutually beneficial objectives.

The primary benefit of a dual water system is a reduction in demand for potable water. The expansion of existing treatment plants or the construction of new facilities might therefore be deferred or even eliminated. Also, depending on the dual system scheme, additional benefits may result such as reduced wastewater flow, control of storm runoff, and overall reduction in water drawn from traditional sources.

Presented below are general design parameters and various conceptual schemes of dual water systems followed by an investigation of applicability to the various growth concepts under consideration.

The next major section of this report details alternative dual systems within the home and quantifies potential water-use reductions.

<u>General Design Parameters.</u> The percentage mix of potable and non-potable water in a dual system depends on the types of land uses serviced and the extent of non-potable water acceptance for each category. The four alternative growth patterns under consideration represent a wide range of land use concepts, and each pattern has its own unique dual system suitability factors.

Plans A and D involve extensive growth in undeveloped areas, but at low density. Plan C envisions high density growth but much of it occurs within areas already serviced with water distribution mains. Plan B portends high density development in new areas but the total growth is allocated among several separate and distinct nuclei.

All four growth plans envision a 1995 population of approximately 47% greater than the 1973 figure. As presented earlier, water demands of this growth do vary somewhat among the four plans. However, for purposes of inspecting dual systems, an average increase in municipal system water demand of 76 MGD (based on 1995 average annual usage)

will be assumed. To further facilitate analysis, it will be assumed that up to 80% of this increased water demand (allocated as 50% residential, 20% commercial, 25% industrial and 5% public and recreational) will be geographically situated such that it could be served by a dual system.

As will be illustrated in the following major section of this part of the report, only 5% of domestic (in-house) water use must be potable. For general design purposes here, though, only toilet flushing and lawn sprinkling will be considered candidates for non-potable water use. These two categories of use account for 49% of average annual residential water demand. (Although density and hence lawn sprinkling varies among the four growth concepts, an average of 15% for lawn sprinkling has been used for all four plans to facilitiate analysis of the dual-system concept).

For estimating purposes, up to 40% of commercial, 75% of public (mainly golf course sprinkling), and 25% of industrial water requirements will be assumed to be fulfilled by non-potable quality water. The industrial percentage has the potential of being higher; a lower figure is used, however, based on the assumption that the food industry will continue to be a major economic force.

Summarizing the above assumptions for municipal system water demands in 1995:

*35% of the total water supplied would be in a dual system.

*43% of the dual system water use would be in a non-potable distribution network.

*Therefore, 1995 potable water demand could be reduced by 26 MGD (average annual) through the dual system concept.

Meeting fire flow requirements will be a major, if not overriding, design factor in a dual water system. Although each of the two distribution systems would be required to supply approximately one half of the average annual water demand of a combined system, the one system of the two which provides fire protection must still meet the fire flow requirements of the entire population serviced by the dual network.

To be consistent with the goal of reducing unnecessary use of potable water, fire flow should be met by the non-potable system. This would allow greatly reduced pressures on the potable distribution system and would therefore incorporate another water-use reduction

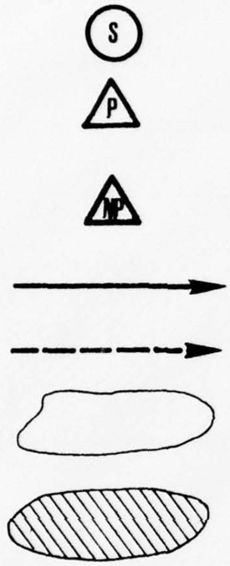
concept. (See above sub-sections discussing system pressure reduction and reduced flow through shower head modification; lower pressure on the non-potable system would not be expected to result in significant use reductions).

The potable distribution system would have only low to moderate daily and hourly peaks since it would serve basically domestic requirements. The non-potable system, on the other hand, would have high seasonal, daily and hourly peaks. Since the non-potable system would therefore need to be sized larger anyway to meet these peaks, it would be appropriate to design it to meet fire flows also. System reliability and adequate storage capacity would obviously need to be incorporated into the design of the non-potable system to meet fire flow requirements. (Note: Storage reservoirs on the non-potable system would not have to be covered and would therefore be less costly than otherwise).

Since one of the components of a dual system can be at low pressure, differential pipe material could be used. This would not only reduce cost but also provide a safeguard against inter-system connection.

Basic alternative schemes

Key to symbols:



water supply source

treatment to potable quality, if necessary

treatment to non-potable quality, if necessary

potable supply distribution

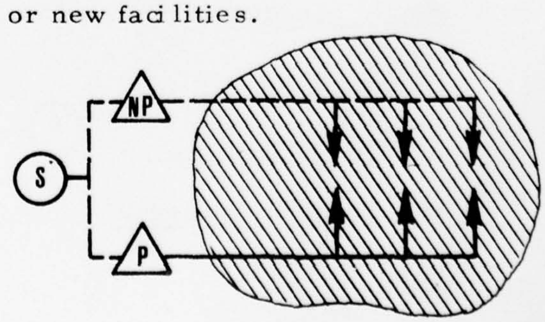
non-potable supply distribution

area of existing development

area of new development

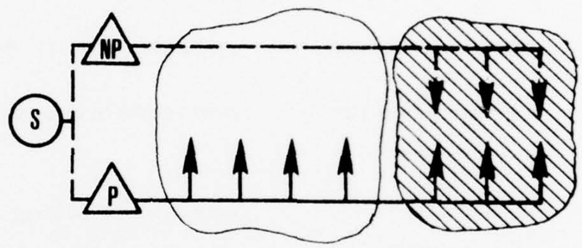
Following are six basic conceptual alternatives. These schemes consider single versus dual sources, single versus dual distribution, and treatment located at or distant from the source. The source of raw water may be any one of a combination of river (surface), reservoir, ground water, storm runoff, or treated wastewater; and existing, expanded or new facilities.

1. Single source, new development in close proximity to source



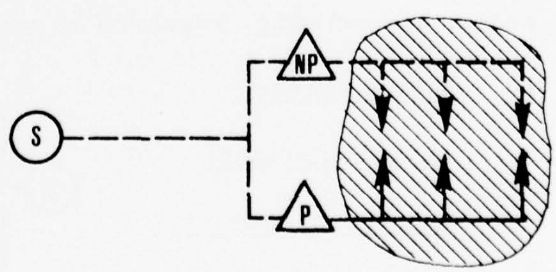
In this scheme, the source of supply could be either existing or new. For an existing source, the assumption is that land near the source is developable. This would apply, for example, to the Florence M. U.D. facility where extensive amounts of undeveloped land exists to the north and east on the Iowa side.

2. <u>Single source, new development distant from source, treatment at source.</u>



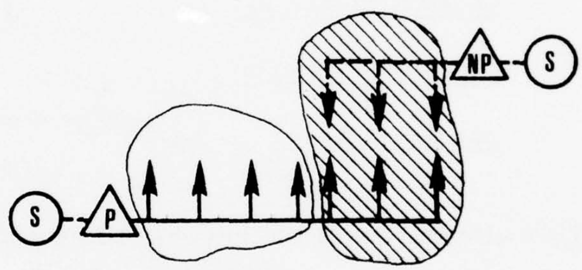
This scheme applies to a situation where new development is distant from the existing source from which it would draw its potable water. The potable water would therefore be supplied by extending the existing distribution system. The non-potable water would be transported through existing development (without serving it) to the new growth area.

3. <u>Single source, new development distant from source, treatment at customer base.</u>



If, as in concept #2 above, the customer base is distant from the supply source, but the potable water is not to come from extension of existing mains, it may be economically desirable to treat the water near its area of use. This would eliminate the need to install parallel distribution mains over a long distance.

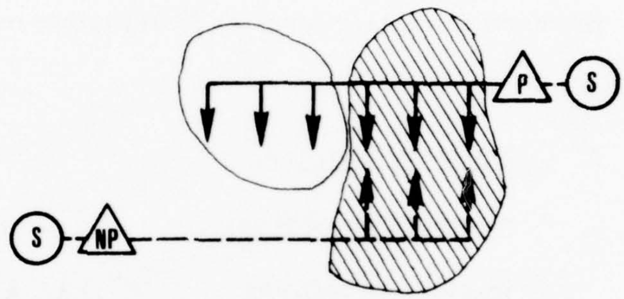
4. Separate sources, non-potable source in close proximity to customer base.



If localized sources of water exist, it may be appropriate to draw the two qualities of water from different sources. This would be especially appropriate if one or both supplies were incapable of meeting the total water demands of the applicable area. As depicted in this scheme, potable water would be provided by extension of the existing distribution system. The non-potable source is depicted as being in close proximity to the new development area. In the study area, the non-potable source for such a situation would most likely be ground water, but could also be a reservoir in the Papio watershed project, impounded storm water, or treated wastewater from a decentralized facility. On a small, localized scale of

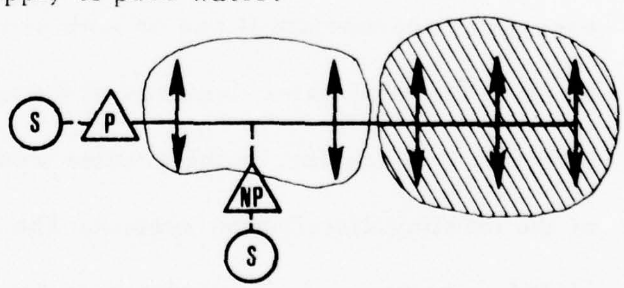
development, the non-potable source might come from surface water which is a part of a golf course or other recreational facility and would serve the immediate surrounding residential and commercial development as well as the central facility itself.

5. Separate sources, potable source in close proximity to customer base.



This alternative is the reverse of #4 above. Depending upon the quality of raw water and the relative proportions of water required from the two sources, it could be more appropriate to utilize the localized source as the supply of pure water.

6. Separate sources, single distribution.



Alternatives #1 thru #5 above all incorporate a complete secondary distribution system. This scheme simply involves augmenting an existing supply of pure water to accommodate increased demands. The secondary source could be treated wastewater or storm runoff,

or more traditionally, ground water. Under this concept, the secondary source may or may not meet potable standards prior to mixing with the primary supply but would be mixed in such proportions which would insure that the combined flow would be of potable quality.

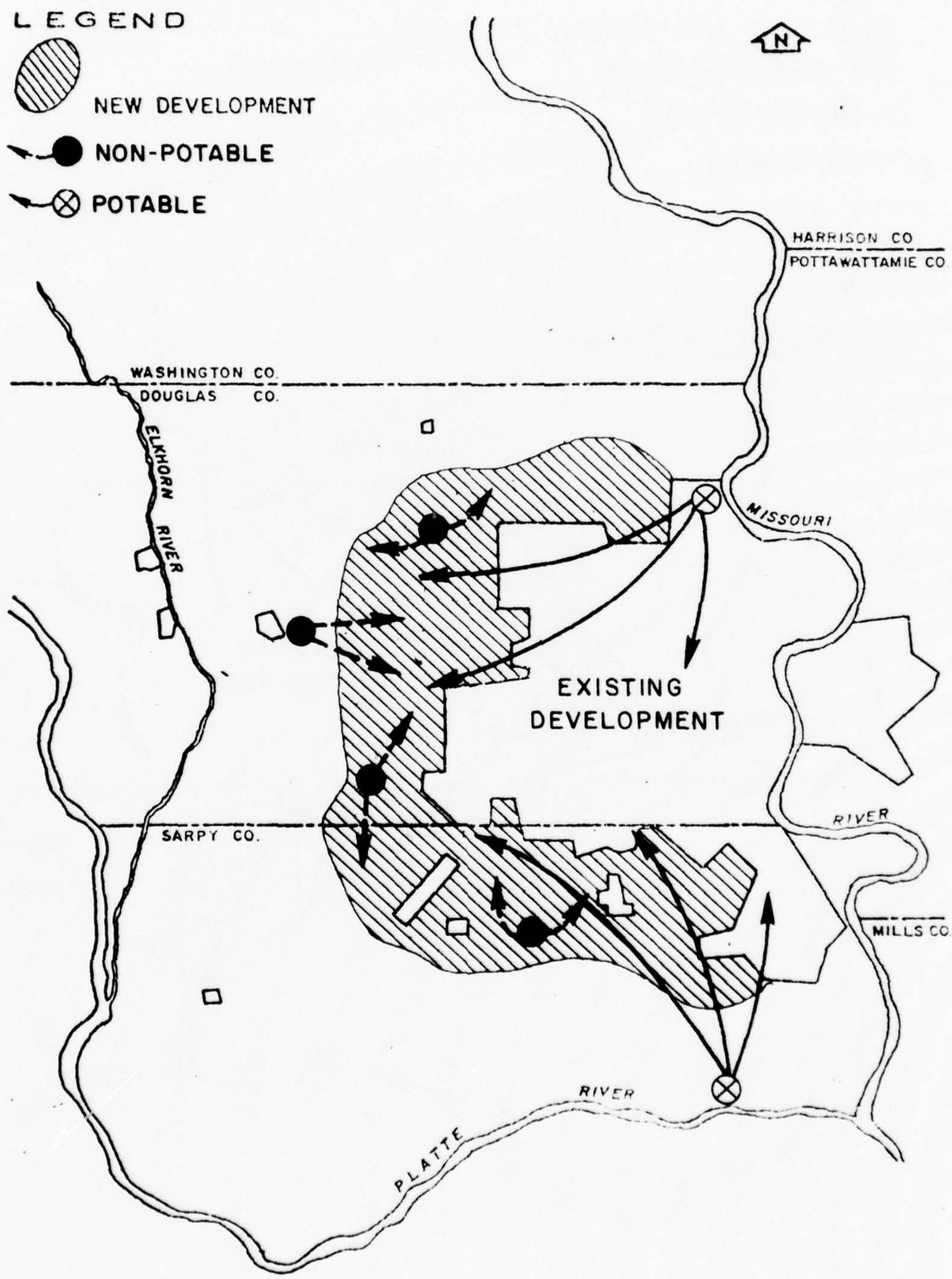
Applicability to alternative growth patterns. As stated earlier, the concept of a dual water system merits practical consideration only in areas of new growth or extensive redevelopment where intra-structure dual piping can be installed at the time of construction. Consideration of dual-system applicability to the four alternative future land use patterns will therefore involve only new structural growth. Suggestions below relative to the four growth patterns are based on conceptual feasibility alone. Cost-effective analyses of employing dual systems instead of more traditional system expansion have not been developed for this interim report.

Growth Pattern A. Under Plan A, essentially all of the region's growth occurs contiguous to current Omaha development in the areas northwest, west, southwest, and south of the City. Since this growth consumes the largest geographic area of the

four plans (and thus at the lowest density), the dual water system concept is least appropriate, cost wise, for Plan A. Of the six basic schemes described above, numbers 2, 4 & 5 would be most applicable. Figures IV-1, IV-2 and IV-3 conceptually illustrate these alternatives for Growth Plan A.

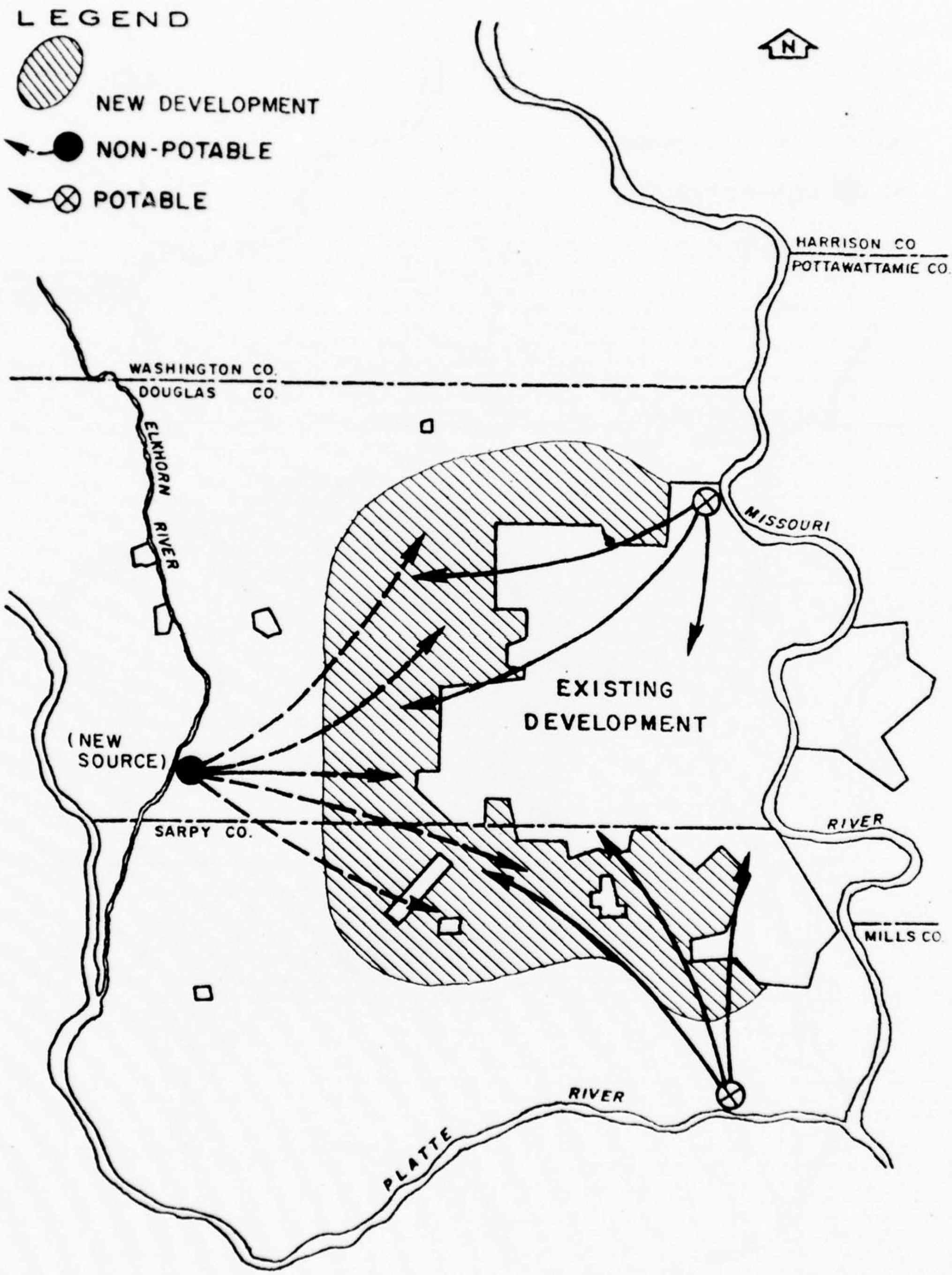
Growth Pattern B. In Plan B, population growth occurs both in and contiguous to the Omaha-Council Bluffs developed area as well as in the satellite cities which are separated from the metro core by a "green belt." Because their growth will involve high percentage increases at high densities and they will be somewhat isolated from the metro core area, these satellite cities offer unique possibilities for dual water systems. For the 50 year planning horizen, projected populations of the several satellite cities range from 10,000 to 35,000 involving percentage growths ranging from 180% to 2,500%. Current treatment (where existing) and well capacities of these cities are generally insufficient to handle total water demands of forecasted Plan B populations. For some of the cities, e.g. Bennington and Blair, new sources of supply would also be required.

Depending on the supply capacity of local sources, dual system schemes 1, 3, 4 & 5 above may be applicable. A satellite city



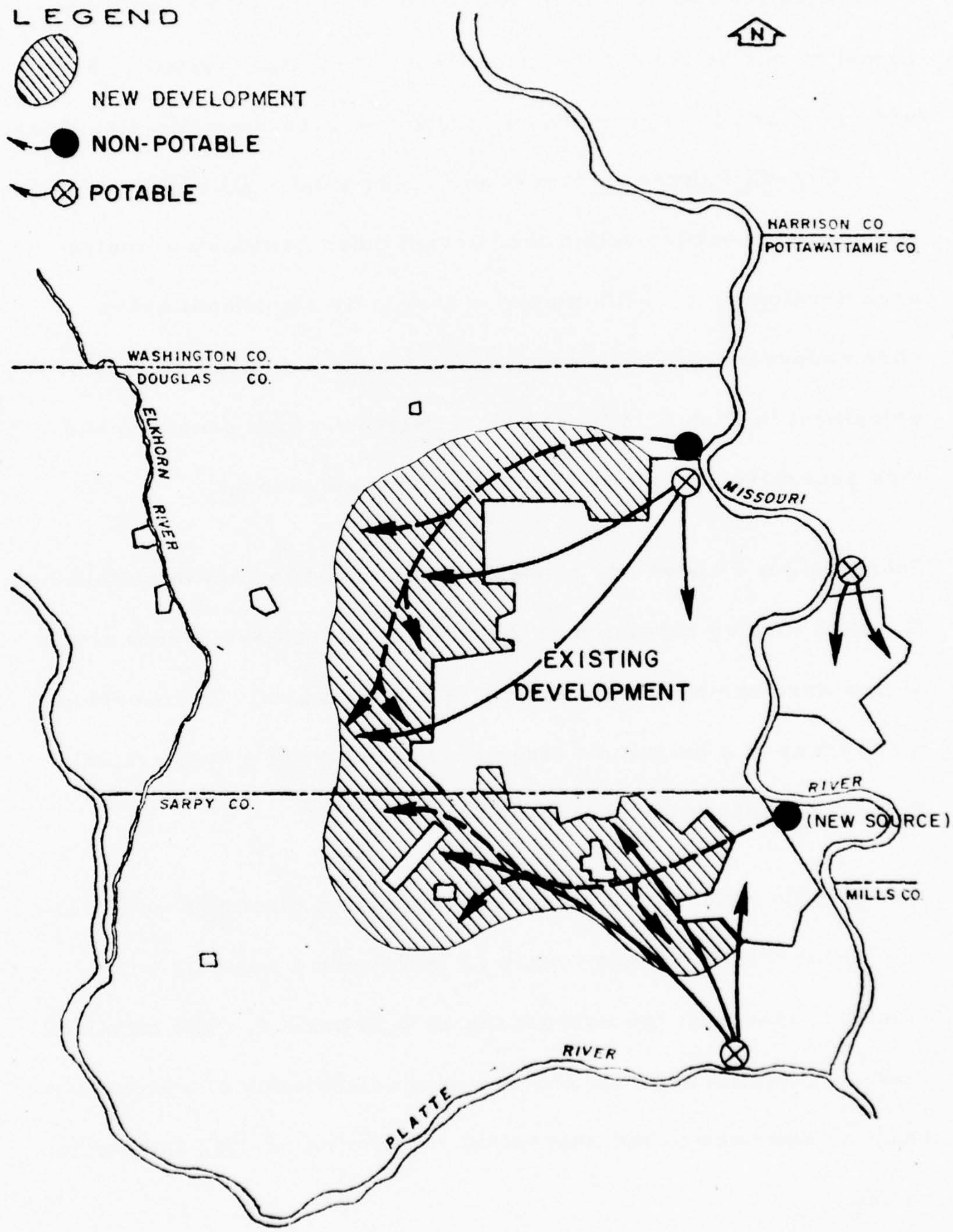
GROWTH PLAN A-1

FIGURE IV-1



GROWTH PLAN A-2

FIGURE IV-2



GROWTH PLAN A-3

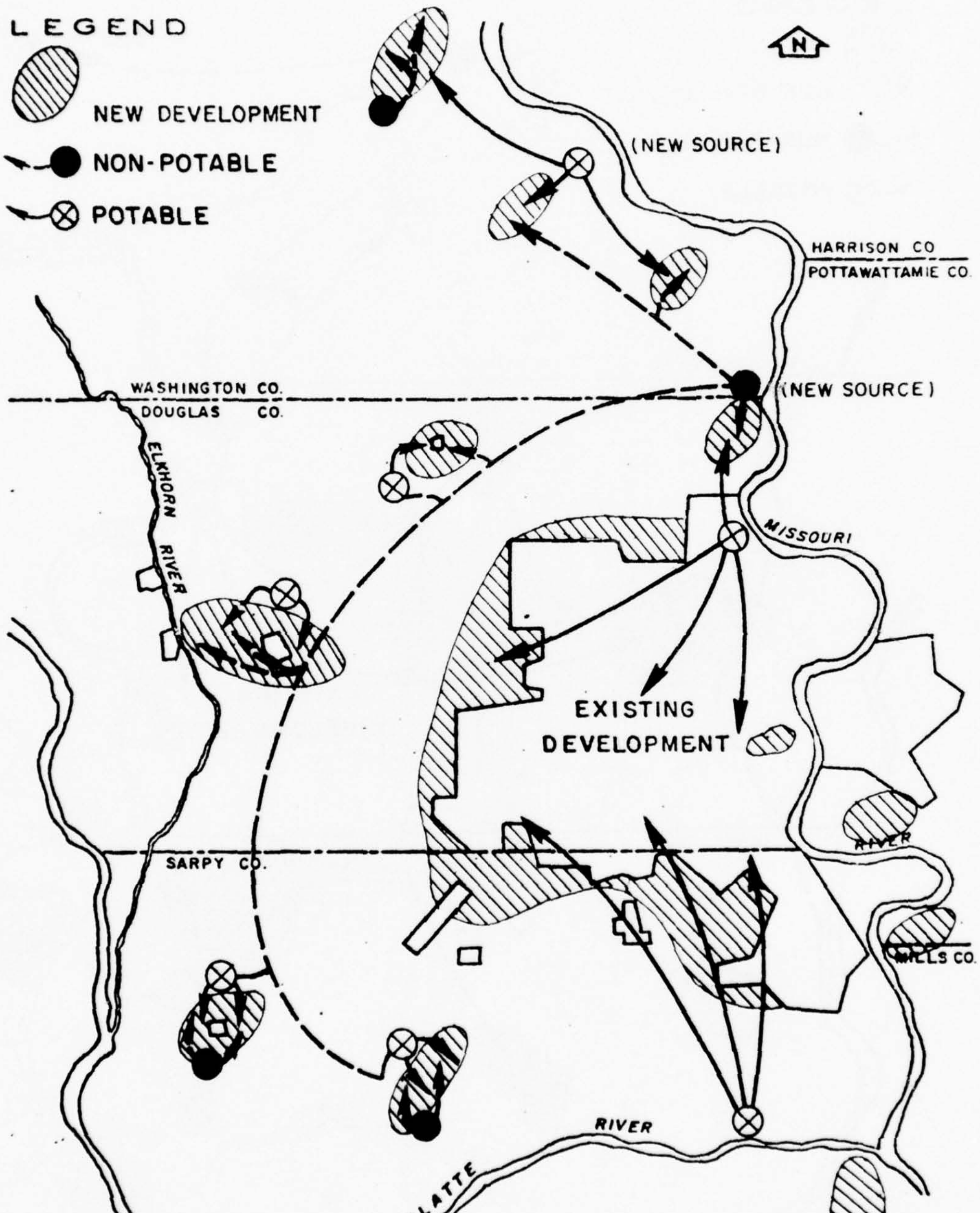
FIGURE IV-3

could have its own system or two or more of the cities could be linked by one or both of the components of the dual system. Figures IV-4 and IV-5 conceptually portray several possible situations.

Growth Pattern C. In Plan C, essentially all of the population growth occurs within the current outer boundary of metro area development. This plan also forecasts significant urban core redevelopment with subsequent increases in population. Development in Plan C is therefore at relatively high densities and thus generally supportive of the dual-system concept.

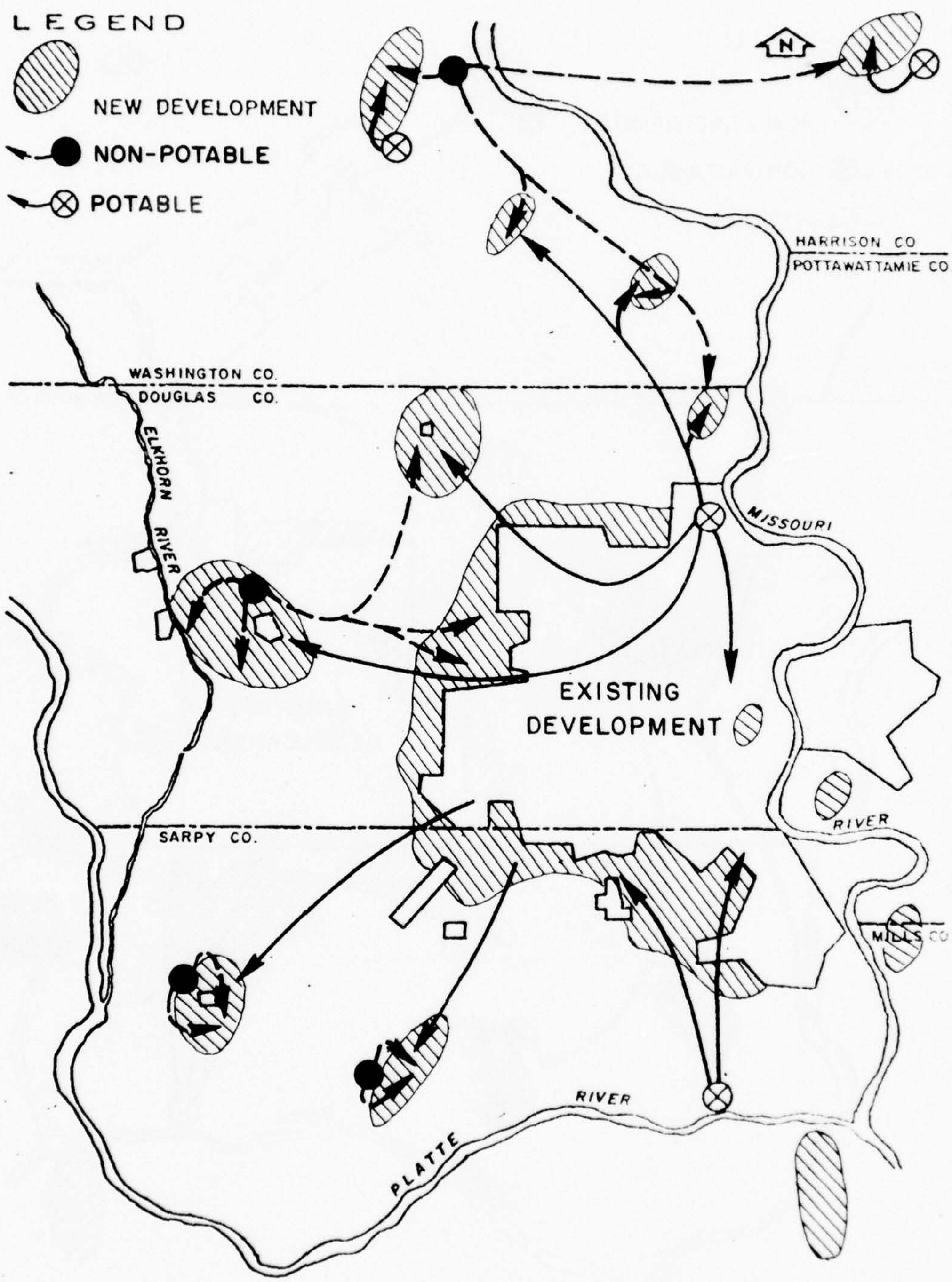
Schemes 2 & 4 above are probably most suited to growth pattern C. Both involve extension of the existing water system into areas of new development as the source of potable water. In redevelopment areas of a magnitude large enough to justify a dual system, the potable supply would already be available.

Non-potable water could be either transported through existing development from a distant source as in Scheme 2 or could come from a source near the new growth as in Scheme 4. The localized sources could incorporate any one or a combination of wastewater reuse, flood control and recreation reservoirs, wells, and storm runoff.



GROWTH PLAN B-1

FIGURE IV-4



GROWTH PLAN B-2

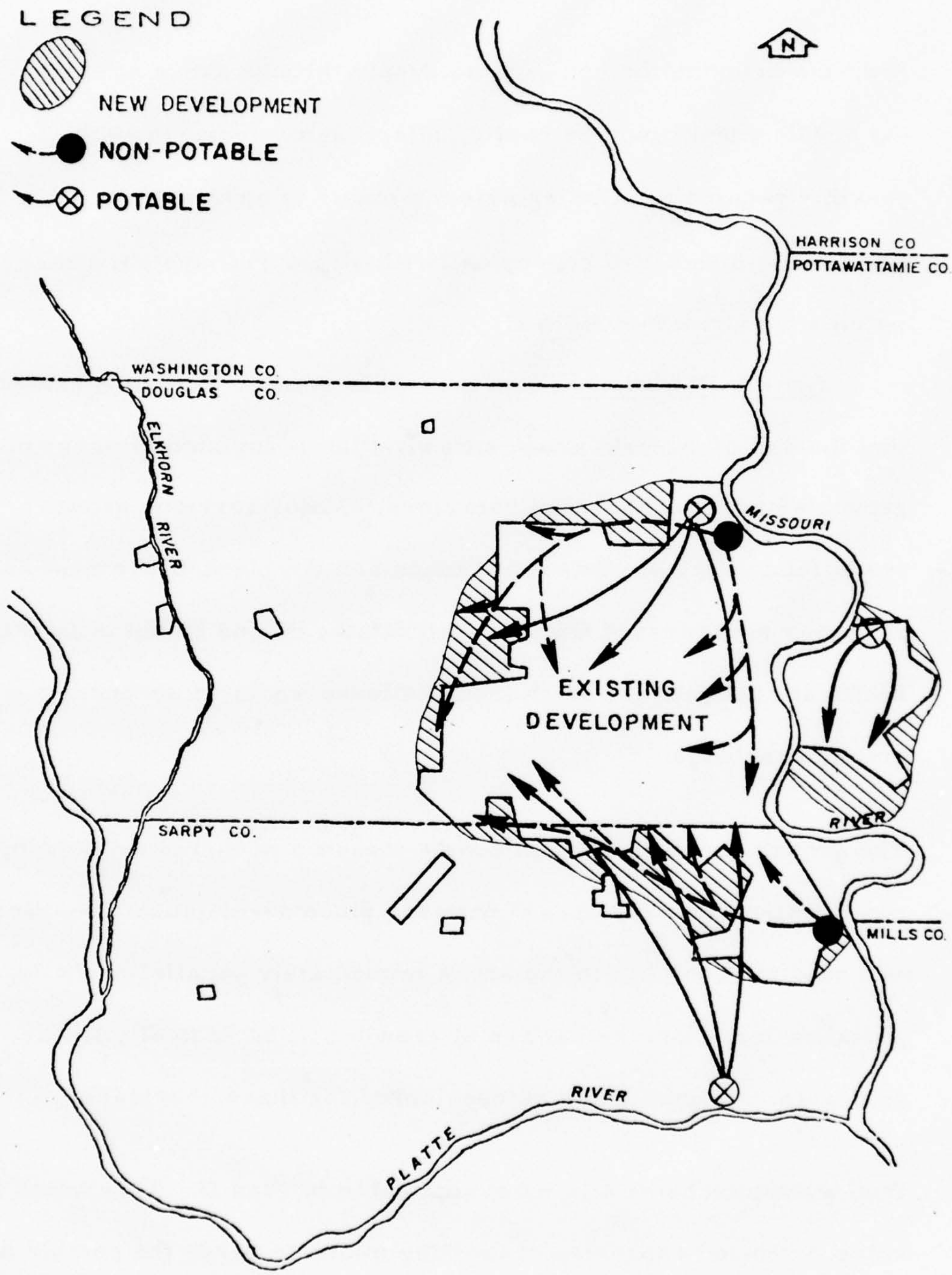
FIGURE IV-5

Although bringing the non-potable supply through areas of existing development would be costly, future water demands could possibly require paralleling existing mains in any case (for Plan C). Figures IV-6 and IV-7 conceptually illustrate dual system alternatives for Growth Pattern C.

Growth Pattern D. Plan D is quite similar to Plan A except that instead of uniform urban sprawl, Plan D envisions fingers of growth along transportation corridors. Major corridor growth would follow I-80 southwest of Omaha and the planned Fremont expressway northwest of Omaha. Interstates 80 and 29 out of Council Bluffs and Highway 73 south from Bellevue would be secondary growth corridors.

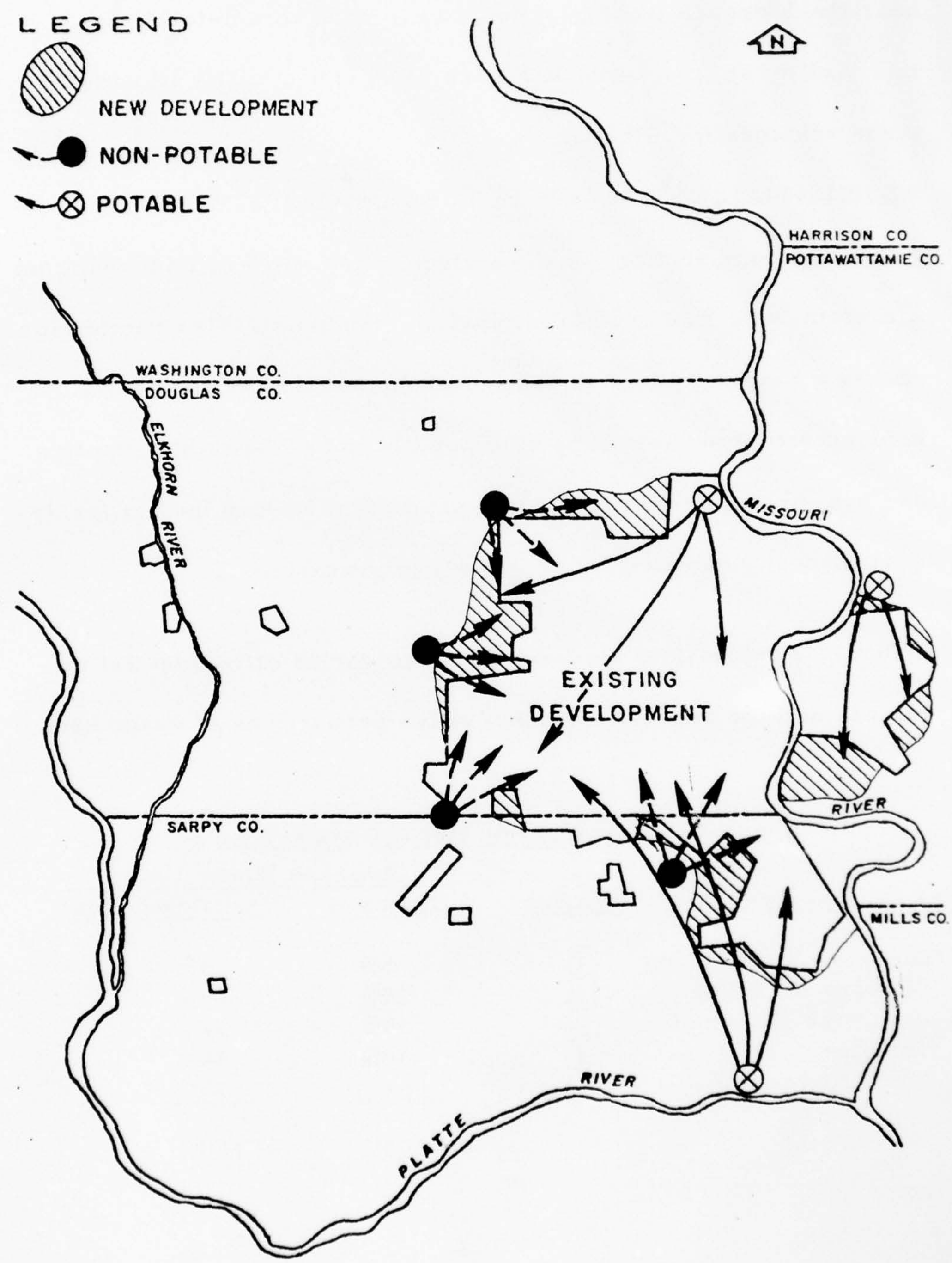
The growth corridor concept adds a measure of increased development control over the sprawl pattern. Since development densities will tend to be higher in the areas immediately parallel to the transportation lanes and the pattern of growth will be basically linear, dual water systems could be considered for these corridors.

Dual system scheme 4 is most applicable to Plan D. This would involve continued expansion of existing mains to serve the potable demands with separate non-potable supplies to serve each of the major growth corridors. The population expansion envisioned in the area



GROWTH PLAN C-1

FIGURE IV-6



GROWTH PLAN C-2

FIGURE IV-7

near the Florence treatment could be served completely from this facility as in scheme 1. Figure IV-8 conceptually illustrates these schemes for Plan D.

RESIDENTIAL, INTRA-STRUCTURE DUAL SYSTEMS

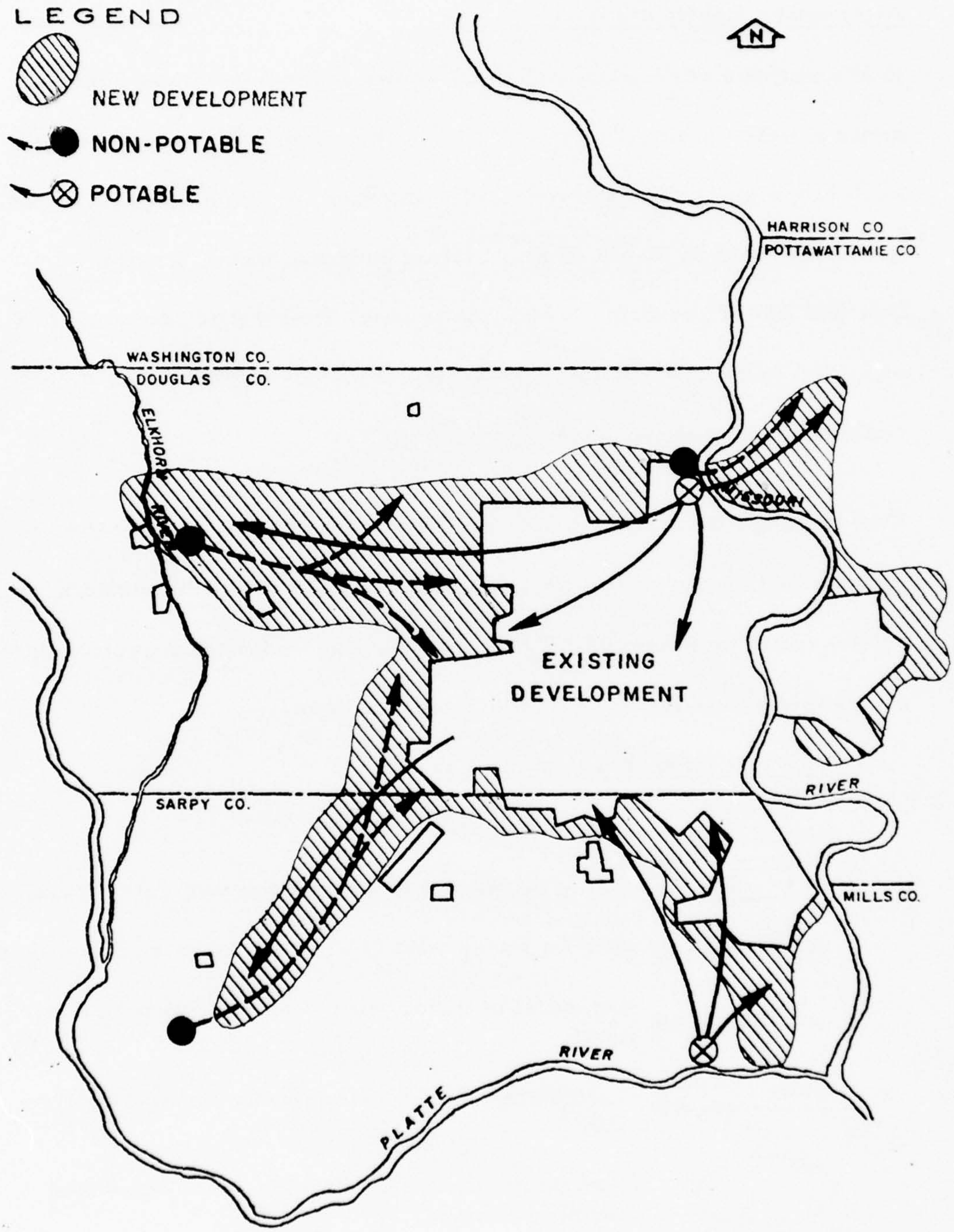
In the previous section, dual water concepts were considered from a system-wide supply and distribution standpoint. This section inspects a range of possible configurations within the residential housing structure assuming both potable and non-potable supplies are available. In addition, configurations involving locally (or decentralized) generated reuse water are presented.

Table IV-6 below lists the five basic categories of residential water use and the average annual relative proportions of water use.

Table IV-6

RESIDENTIAL WATER USE BY CATEGORY

Category	Symbol	Average Water Use Domestic	Average Water Use Total Residential
Drinking and Cooking	1	5%	4%
Laundry & Dishes	2	20%	17%
Bathing & Personal	3	35%	30%
Toilets	4	40%	34%
Lawn Sprinkling	5	--	15%
Total		100%	100%



GROWTH PLAN D-1

FIGURE IV-8

Alternative Configurations

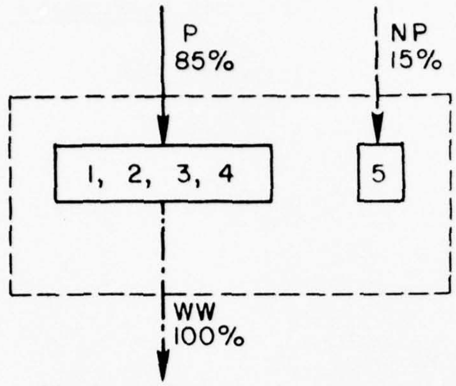
In the various conceptual schemes shown below, each box represents a water piping "network" within the home. The numbers in each box signify the categories of water use involved and are keyed to the symbols in Table IV-6. Arrows indicate water flowing into and out of the home. Maximum water flow out (wastewater) is assumed to be 100% of total possible domestic water use, i. e. all residential use except lawn sprinkling.

A wide range in potable water use reduction is indicated by the various configurations below; likewise, a wide range in public acceptability could be expected. Table IV-7 at the end of this section summarizes various features of the configurations.

Symbols used in diagrams below:

	residential unit.
$\boxed{1, 2}$	piping network and associated use categories.
$\xrightarrow{X\%}$, P	potable water with % of total water requirement.
$\xrightarrow{X\%}$, NP	non-potable water with % of total water requirement.
$\xrightarrow{X\%}$, WW	wastewater with % of domestic water requirement.
	home or small scale filtering, treatment and pumping system.

1.



Quantity Reductions:

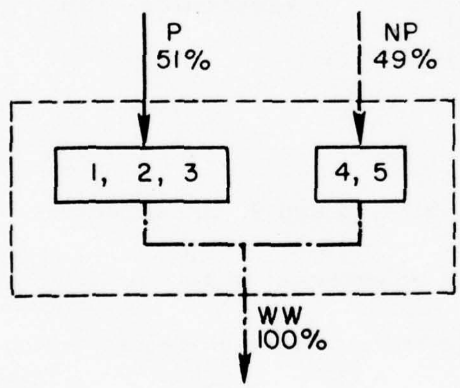
Potable, 15%

Total use, none

Wastewater, none

Notes: Since only external plumbing is involved in the non-potable system, this alternative could be applicable to existing structures (i. e. modification to existing plumbing would not be major).

2.



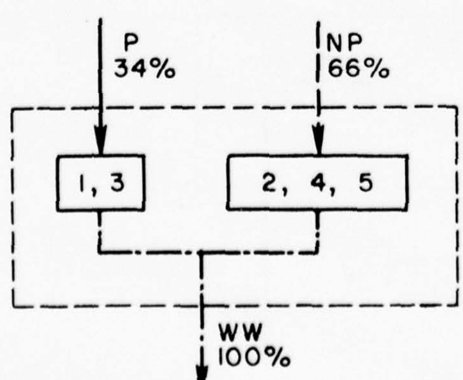
Quantity Reductions:

Potable, 49%

Total use, none

Wastewater, none

3.



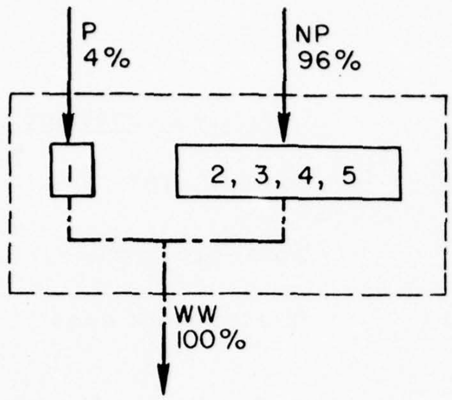
Quantity Reductions:

Potable, 66%

Total use, none

Wastewater, none

4.



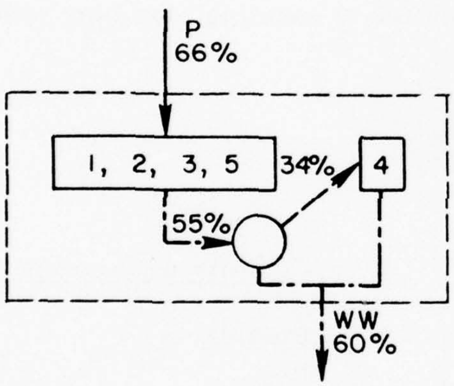
Quantity Reductions:

Potable, 96%

Total Use, none

Wastewater, none

5.



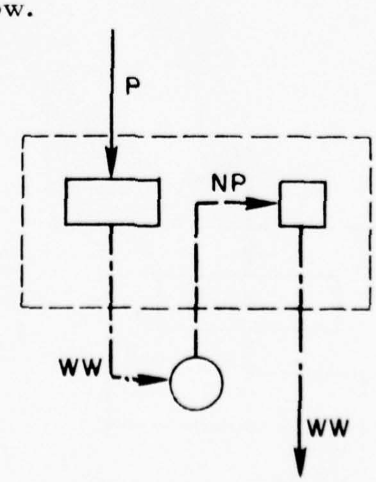
Quantity Reductions:

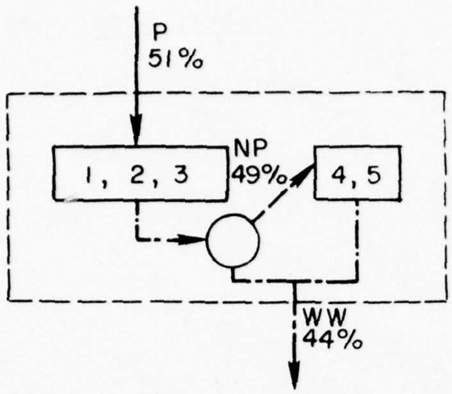
Potable, 34%

Total Use, 34%

Wastewater, 40%

Notes: In configurations 5, 6, 7, 8 and 9, the filter-treatment-pumping unit may be external to an individual unit, i. e. it may serve two or more units, as indicated by the diagram below.



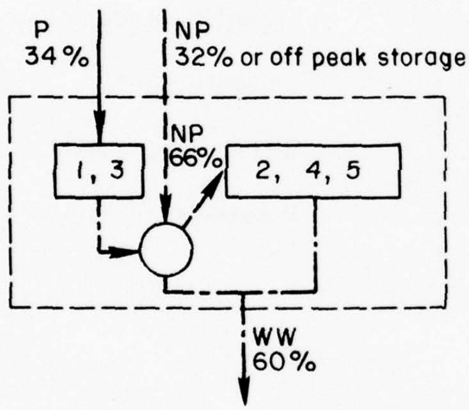
6. 

Quantity Reductions:

Pota'le, 49%

Total Use, 49%

Wastewater, 56%

7. 

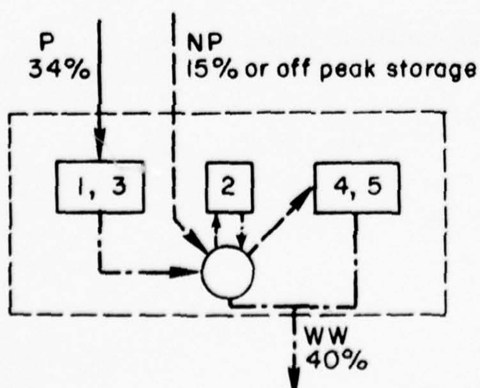
Quantity Reductions:

Potable, 66%

Total Use, 32%-66%

Wastewater, 40%

Notes: In configurations 5 thru 9 and especially 7 & 8, the reuse supply water may have to be augmented by an external supply or from off-peak storage.

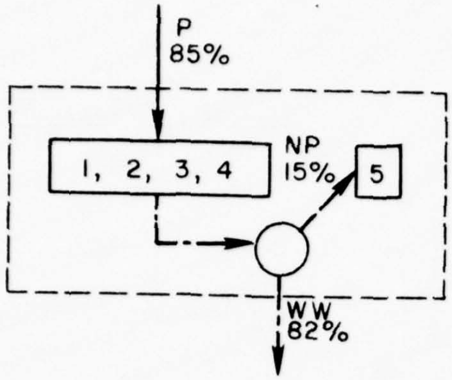
8. 

Quantity Reductions:

Potable, 66%

Total Use, 51%-66%

Wastewater, 60%

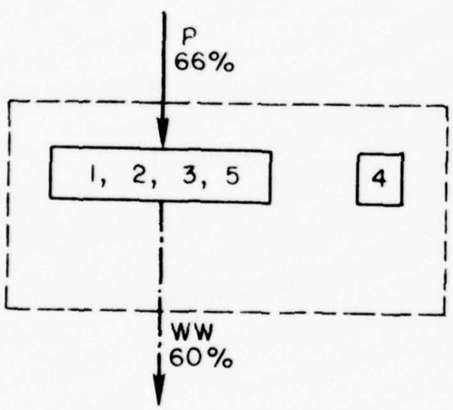
9. 

Quantity Reductions:

Potable, 15%

Total Use, 15%

Wastewater, 18%

10. 

Quantity Reductions:

Potable, 34%

Total Use, 34%

Wastewater, 40%

Notes: This configuration envisions non-water using toilets.

Summary

Table IV-7 summarizes the above ten configurations regarding 1) potable water use reduction, 2) total water use reduction, 3) wastewater flow reduction and 4) public acceptability.

TABLE IV-7

SUMMARY OF RESIDENTIAL DUAL-SYSTEM AND RECYCLED WATER CONCEPTS

ALTERNATIVE	POTABLE SUPPLY REDUCTION	WASTEWATER FLOW REDUCTION	TOTAL WATER REQUIREMENT REDUCTION	EXPECTED PUBLIC ACCEPTABILITY
1	15%	NONE	NONE	GOOD
2	49%	NONE	NONE	GOOD
3	66%	NONE	NONE	FAIR
4	96%	NONE	NONE	POOR
5	34%	40%	34%	GOOD
6	49%	56%	49%	FAIR
7	66%	40%	32 - 66%	POOR
8	66%	60%	51 - 66%	POOR
9	15%	18%	15%	FAIR
10	34%	34%	40%	FAIR

WATER USE REDUCTION CONCEPTS SUMMARY

TableIV-8on the following page presents the basic use-reduction concepts discussed in previous sections of this report. The concepts are compared among several evaluative factors. When considering the various concepts it is important to note that 1) some are mutually exclusive, e. g. water conserving toilets and non-water using toilets; 2) some are interrelated and dependent, e.g. the necessity to take certain legal actions to implement a dual system; 3) some are overlapping, e. g. when a dual supply involves system pressure reduction; and 4) some are additive and mutually supportive, e. g. a price increase and the use of water conserving fixtures. Figures IV-9 and IV-10 depict the effect of water use reduction concepts on future levels of water consumption.

TABLE IV-8
SUMMARY OF WATER
USE REDUCTION CONCEPTS

WATER USE REDUCTION CONCEPTS				% REDUCTION PER APPLICABLE RESIDENTIAL CUSTOMER (DWELLING UNIT)			1995 TOTAL POTABLE SUPPLY REDUCTION		ALTERNATIVE SUPPLY CONCEPTS			SCOPE OF APPLICABILITY		TECHNOLOGY REQUIRED			INVESTMENT TO IMPLEMENT		PUBLIC ACCEPTABILITY
				POTABLE WATER SUPPLY REQUIREMENTS	TOTAL WATER SUPPLY REQUIREMENTS	SEWAGE FLOWS	PERCENT	ACTUAL (AVERAGE ANNUAL MGD)	NON-POTABLE SUPPLIES: WELLS, SURFACE WATER, STORM WATER, ETC.	REUSE SUPPLY: WASTEWATER SYSTEM-WIDE	REUSE: WASTEWATER, INTERNAL SYSTEM	TOTAL POPULATION	NEW GROWTH AND LAND DEVELOPMENT	EXISTING	DEVELOPING	NEW	PUBLIC	PRIVATE	
				%	%	%	%	MGD											
	NON - STRUCTURAL	1	VOLUNTARY ACTION: WATER CONSERVATION ATTITUDES	NA	NA	NA	NA	NA	NA	NA	NA	X		X			MINOR		GOOD
		2	LEGAL ACTIONS	NA	NA	NA	NA	NA	NA	NA	NA	X		X			MINOR		FAIR
		3	INDUSTRIAL DEVELOPMENT PROMOTION	NA	NA	NA	7%	12MGD	NA	NA	NA		X	X			MINOR		GOOD
		4	PRICING POLICIES (50% PRICE INCREASE)	17%	17%	5%	11%	20MGD	NA	NA	NA	X		X			MINOR		FAIR
		5	METERING OF INDIVIDUAL APARTMENT UNITS AND MOBILE HOMES	25%	25%	25%	3%	5MGD	NA	NA	NA	X		X			MODERATE		GOOD
	STRUCTURAL	6	WATER CONSERVING FIXTURES AND APPLIANCES	6 TO 31%	6 TO 31%	7 TO 39%	.8 TO 4.0%	UP TO 7 MGD	NA	NA	NA	X		X	X			MODERATE	FAIR-GOOD
		7	WATER ELIMINATING TOILETS	32%	32%	40%	5.1%	9 MGD	NA	NA	NA	X			X	X		MODERATE	POOR-FAIR
		8	SYSTEM PRESSURE REDUCTION						NA	NA	NA	X		X			MODERATE		FAIR-GOOD
		9	LEAKAGE AND LOSS CONTROL						NA	NA	NA	X		X			MODERATE		GOOD
		10	DUAL SUPPLY & DISTRIBUTION, SYSTEM WIDE	49%	0 TO 49%	0	15%	26MGD	YES	YES	NO		X	X	X		MAJOR		POOR-GOOD
		11	UNITIZED RESIDENTIAL RECYCLING (ASSUME UP TO 50% NEW HOUSING)	15 TO 66%	0 TO 66%	0 TO 60%	UP TO 6%	UP TO 10MGD	YES	NO	YES		X		X	X		MAJOR	POOR-FAIR

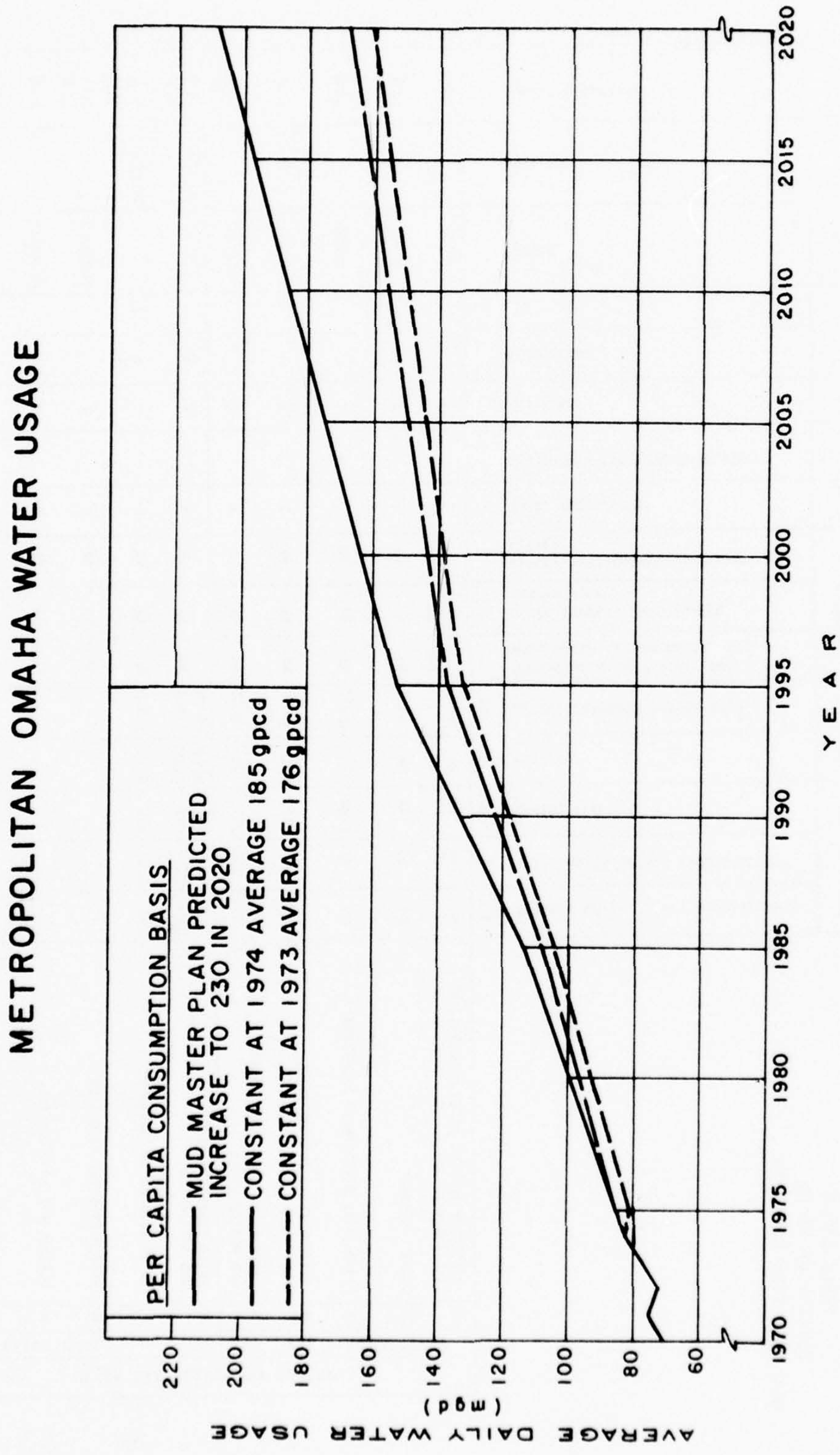

METROPOLITAN OMAHA WATER USAGE
PER CAPITA CONSUMPTION BASIS
MUD MASTER PLAN PREDICTED INCREASE TO 230 IN 2020
CONSTANT AT 1974 AVERAGE 185 gpcd
CONSTANT AT 1973 AVERAGE 176 gpcd
AVERAGE DAILY WATER USAGE (mgd)
220
200
180
160
140
120
100
80
60
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
YEAR

FIGURE IV - 9

EFFECT OF REDUCTION CONCEPTS ON METROPOLITAN AREA WATER USAGE

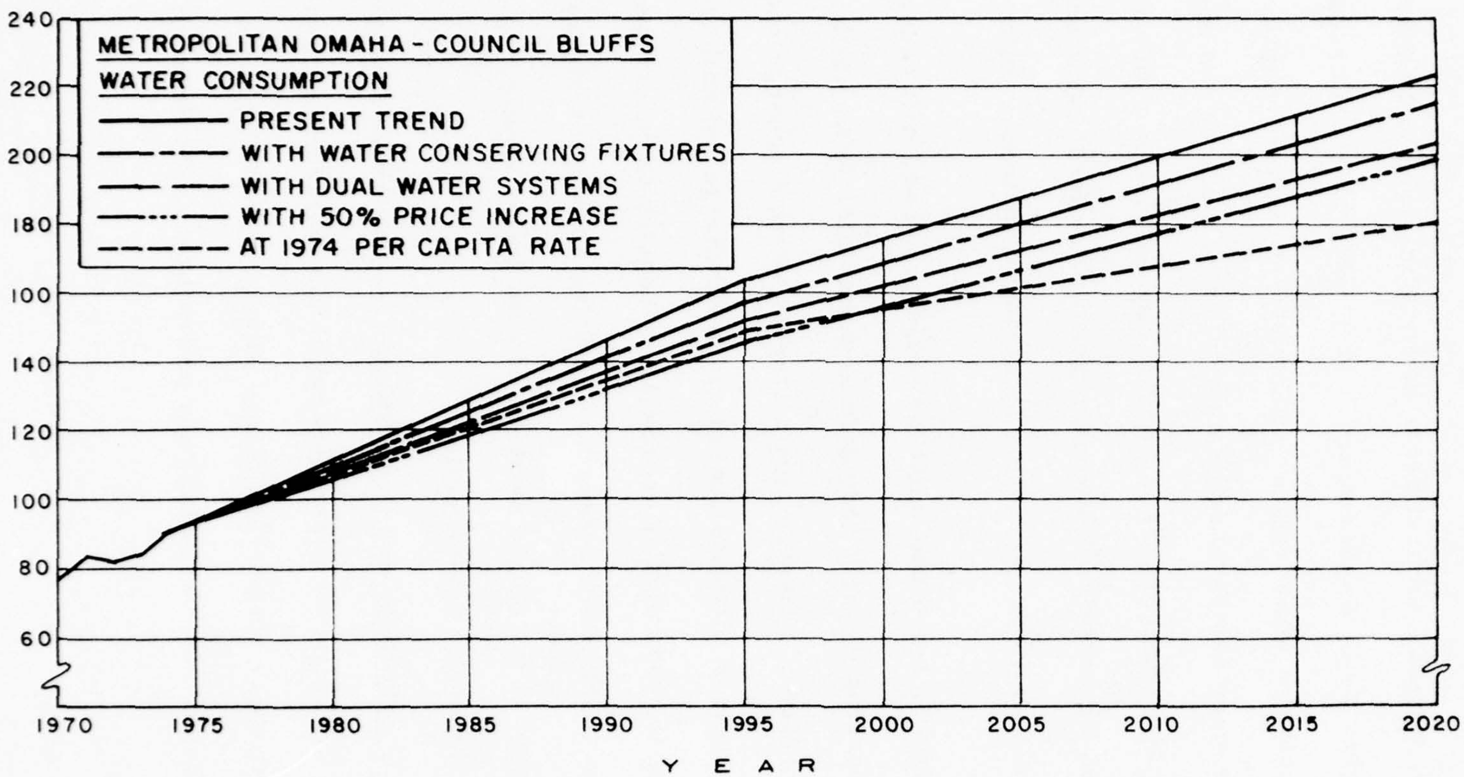


FIGURE IV - 10

INDUSTRIAL USE REDUCTION

Major non-agricultural users in the study area in 1973 are listed in Table II-3. A determination of precise water use reduction possibilities would require an industry-by-industry, process-by-process survey to determine current practices and applicability and effect of existing technology. A survey of this type is beyond the scope of this report; however general comments on possible water use reduction by industrial category follow.

It should be noted that most industries have and will reduce water consumption with reduction in wastewater flows as the compelling factor. Increasingly stringent waste discharge requirements with an ultimate goal of "zero discharge" of pollutants is making it economically beneficial to industry to reduce waste stream quantity and strength. Thus, the economics of wastewater treatment is the single most significant factor in bringing about industrial water use reduction.

Electrical Power Generation. Cooling water used by the five area electrical power generation plants far exceeds other industrial water usage. All plants withdraw water from the Missouri River and return essentially the entire flow to the River at an

increased temperature. Use of cooling towers and recycling of water rather than the once through method now commonly used could reduce water withdrawal 90 percent. However, actual consumption of water would increase due to evaporation at the cooling tower.

Food Processing Industries. Major food processors in the study area are meat packers. Up to 95 percent of the water used by the packing industry comes in direct or indirect contact with the animal carcass. Recycle or use of less than potable quality water is therefore not feasible. Conversion to processing methods which reduce or eliminate water usage is therefore the only method by which water consumption could be significantly reduced.

Breweries, bottlers, bakeries, soup manufacturers and other food industries in the study area use major portions of their non-cooling water for cleaning or process water in or around food products. In essentially all food industries, substantial water use reduction through recycling is not feasible because of the high quality process water required and the degree of degradation caused by usage.

Chemical Industry. A large nitrogenous fertilizer manufacturer is the major chemical industry in the study area. About 90

percent of this industry's water usage is for cooling, mostly on a once-through basis. As with electric power plants, additional cooling towers would substantially reduce cooling water requirements. Modifications and updating currently planned by this industry will reduce process water requirements by up to 10 percent.

Other area chemical industries including an alcohol and furfural manufacturer use up to 80 percent of their water requirements for cooling. Water used in chemical processes must be of high quality with advanced production technology presenting the only use reduction possibilities. Changes in cleaning methods and recycle in some instances might affect minor reductions in total industry water consumption.

Electrical Supplies and Equipment. The major area industry producing electrical equipment used about 90 percent of its water for cooling purposes. Economics of waste treatment and product recovery result in probably the minimum water usage practical at the present time.

Primary Metal and Heavy Machinery Industries. A major non-cooling water usage in these industries is air scrubbing. Recycle of scrubbing water, although already practiced in most instances, is an opportunity for water usage reduction.

Fishery. The Fishery listed as a major water user in 1973 is no longer in operation. From the limited information obtained, it is doubtful that water used for make-up in a pond recycle system was very significant. The high (8.8 mgd) usage reported for 1973 was possibly due to initial filling of ponds.

SECTION V

ALTERNATIVE SOURCE CONSIDERATIONS

SECTION V

ALTERNATIVE SOURCE CONSIDERATIONS

MAJOR RAW WATER SUPPLY SOURCES

The major water supply sources in the study area are the Missouri and Platte Rivers. Minor supply sources are the Elkhorn, Boyer and West Nishnabotna Rivers. Omaha and Council Bluffs both utilize Missouri River surface sources as their primary water supply. The remaining major supply sources are from groundwater wells located in sands and gravels along the water courses. Omaha's second water supply source is from Platte River groundwater wells. Moderate to large yield wells (1000 gpm - 3500 gpm) are found along the Platte River in Douglas and Sarpy Counties and in Washington and Harrison Counties along the Missouri River. Smaller yield wells are found along the remaining streams.

Omaha plans to increase supply capacity by further tapping present water supply sources. The Missouri River surface supply of the Florence treatment plant is programmed for expansion in about 1982. Additional well field supply along the Platte River is scheduled later in the planning period along with additional surface supply from the Missouri River.

Missouri River Supply Sources

The Missouri River, although sometimes muddy and polluted, is a

large capacity stream. During the winter months, the U. S. Army Corps of Engineers trys to maintain a 15,000 cfs/day flow in the Missouri River at Omaha. In the winter of 1969 - 1970, the flow averaged between 15,000 and 20,000 cfs/day. As an absolute minimum the Corps has stated that a 5,000 cfs (3,250 mgd) flow would have a 1% probability of occurring.

River Water Quality. The water in the Missouri River is of fairly good quality; however it is difficult to treat at certain seasons of the year, particularly during periods of spring runoff in the upstream basins. It is interesting to note that the high and low turbidity of the River ranged from 6000 to 4 Jackson Units while the water temperature ranged from 82 degress to 32 degrees Fahrenheit. Missouri River quality is summarized in Table V-1.

Groundwater Quality. At the present time there is not a lot of information available concerning the actual geological features and the groundwater quality along the west bank of the Missouri River. Limited data would indicate that the water bearing formations vary in depth from 100 to 140 feet with good transmissivity. Groundwater from the Missouri River sands and gravels is anticipated to be harder and contain more iron and manganese than the surface water. Total hardness ranges from 472 to 522 mg/l as $CaCO_3$; iron from 5.0 to 8.0 mg/l; and manganese from 0.7 to 1.3 mg/l.

TABLE V-1

MISSOURI RIVER AT OMAHA

Identification	Units	No. of Samples	Mean	Maximum	Minimum	Period of Sampling
Water Temp.	° F	642	52	82	32	57-70
Stream Flow	CFS	777	24,533	116,000	5300	57-68
Turbidity	JU	644	249	6,000	4	57-70
Color	Pt-Co	644	8	56	2	57-70
pH		643	8.2	10.9	7.3	57-70
DO	MG/L	642	9.3	15.2	0.9	57-70
5 day BOD	MG/L	638	2.1	23.0	0.1	57-70
Total Alkalinity	MG/L	646	163	236	86	57-70
Total Hardness	MG/L	645	245	340	108	57-70
Carbonate Hardness	MG/L	63	158	189	16	69-70
Non Carbonate Hardness	MG/L	63	84	95	.01	69-70
Calcium	MG/L	63	62	72	55	69-70
Magnesium	MG/L	63	21	26	16	69-70
Sodium	MG/L	36	61	80	28	62-70
Potassium	MG/L	34	5.8	8.7	.06	62-70
Chloride	MG/L	644	12	80	5	57-70
Sulfate	MG/L	645	194	283	46	57-70
Fluoride	MG/L	84	0.57	0.80	0.06	62-70
Silica	MG/L	15	23	205	5	69-70
Arsenic	MG/L	26	0.06	0.15	0.04	62-70
Barium	MG/L	26	0.07	0.14	0.02	62-70
Cadmium	MG/L	27	0.02	0.05	0.00	62-70
Chromium	MG/L	26	0.01	0.03	0.00	62-70
Lead	MG/L	27	0.04	0.11	0.00	62-70
Total Iron	MG/L	26	0.02	0.05	0.00	62-70
Manganese	MG/L	27	0.01	0.03	0.00	62-70

Alkalinity and Hardness in $CaCO_3$

Source: Water System Master Plan, Metropolitan Utilities District, 1972.

Water Pollution Control Facilities. Another factor for consideration in the use of water from the Missouri River is the location and quality of the discharge of waste waters. The City of Omaha has a combined sewer system, where storm sewer and sanitary sewer flows are carried in the same sewer system. The Missouri river front collection system that was constructed in the early 1960's was designed to direct all normal sanitary flows through a series of pump stations and force mains to the treatment facility located along the west bank of the river just downstream from the South Omaha Bridge.

The City's Missouri River Sewage Treatment Plant presently provides primary treatment only; however studies are underway to implement secondary treatment. During storm flow conditions the diversion facilities provide for the discharge of Missouri River watershed combined storm and sanitary waste waters directly to the river when the dilution ratio exceeds five to one in the North Omaha Interceptor, and three to one in the South Omaha Interceptor. A study is currently in progress to determine the best method for eliminating discharge of untreated combined sewer overflow. The alternatives under consideration include various methods of storage with treatment at the Missouri River treatment plant or the Papillion Creek Sewage Treatment Plant.

The Papillion Creek watershed wastewaters are presently being treated at the City's 60th and Harrison Street Plant with the effluent being discharged to the Papio Interceptor sewer. The long range plan for treatment provides for directing these wastes downstream to a wastewater treatment plant located northwest of the confluence of the Papillion Creek and Missouri River. According to the present time table this facility should be completed to accomplish secondary treatment prior to 1978.

On the Iowa side of the Missouri River, the new Council Bluffs wastewater treatment plant went into operation in late December, 1974. This new waste water treatment facility provides secondary treatment and chlorination. The treated effluent is discharged into the Missouri River at a point across from the Fontenelle Forest area.

Lower Platte Water Supply Sources

The availability of water in the lower Platte River is the subject of three recent studies:

1. State Water Plan, Report on the Framework Study, Nebraska Soil and Water Conservation Commission, May 1971.

2. Platte River Level "B" Study, Missouri River Basin Commission, In-Progress.

3. Ground Water Resources of the Lower Platte Valley, University of Nebraska Civil Engineering Research Series 401, R. R. Marlette & R. E. Brogden, September 1971.

In 1971, R. R. Marlette & R. E. Brogden investigated the groundwater potential of the lower Platte Valley. The area studied encompassed the active floodplain or the valley floor of the Platte and Elkhorn Rivers extending from the Dodge-Douglas County line on the north to the Missouri River confluence on the east.

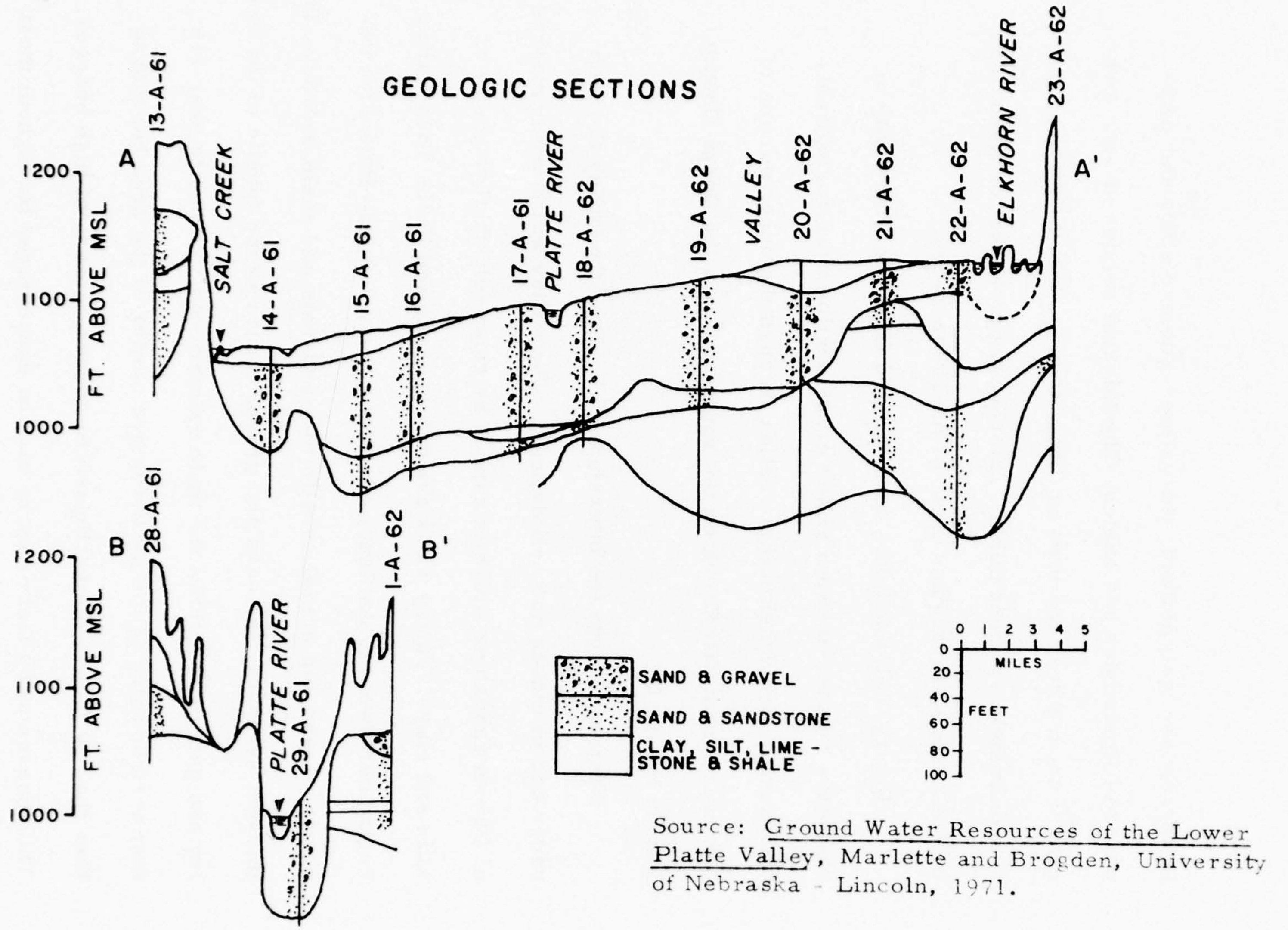
The Lower Platte Valley consists of unconsolidated deposits of sand, gravel, silt and clay overlying older consolidated deposits of sandstone, limestone, and shale. The present valley was formed as ancestral rivers of the Platte River and Elkhorn River responded to the drastic climatic changes during the periods of glacial advance and retreat. As a result, the ancestral rivers eroded and entrenched themselves into the bedrock and later filled their valleys with sand and gravels.

The lower Platte Valley is divided geologically into two regions with the interstate highway the dividing line. Below I-80, the valley

is narrow and well defined, the valley walls are steep and composed of limestones and shales. The thickest section of sand and gravel occurs near the town of Cedar Creek, where they are approximately 100 feet thick. Thicknesses of 40 feet or more may be encountered throughout most of the lower valley.

Figure V-1 which has been adapted from the University of Nebraska report, shows a valley cross section near Springfield, Nebraska, and a longitudinal section through the upper portion of the valley from Salt Creek on the south, through the Dodge County line on the north.

Upstream from the Interstate 80 bridge, the valley is much wider and in places not well defined. The valley walls are composed of Dakota Sandstone which is capped by relatively thick deposits of silts and clays. Valley walls are not as steep and in the Todd Valley region northwest of Ashland, they are poorly defined. Extensive deposits of sand and gravel overlie the sandstone and shale bedrock. The thickest section of the sand and gravel occurs in the middle of the valley and generally follows the main valley trend. Deposits over 110 feet are recorded in the northwestern corner of the area but thin to less than 20 feet in the northeastern corner because of high bedrock. Thicknesses of 60 feet or more may be encountered throughout most of the upper valley.



Source: <u>Ground Water Resources of the Lower Platte Valley</u>, Marlette and Brogden, University of Nebraska - Lincoln, 1971.

FIGURE V - 1

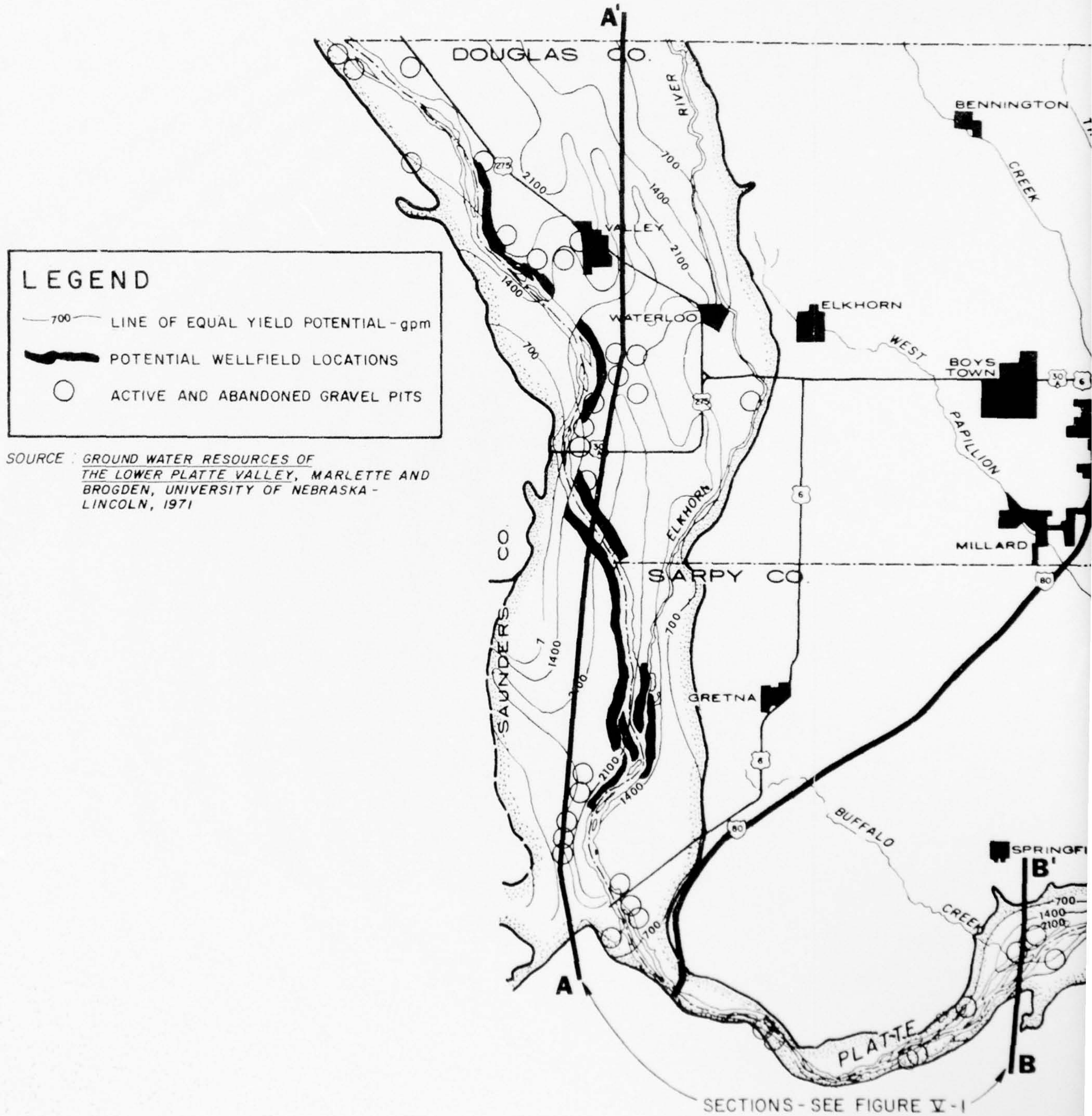
Potential yields of 2100 gpm or greater are generally found in the center of the valley. The yields are somewhat lower nearer the valley edge because of the thinning of the saturated sands and gravels or because of the greater influence of the Dakota Sandstone. Yields of 1400 gpm or more may be readily obtained in most of the valley.

The unconsolidated deposits of sand and gravel are the most permeable and allow water to move freely in the direction of the steepest gradient. Permeabilities may reach as high as 3500-4000 gallons per day per square foot and when completely saturated, yields of individual wells as high as 3500 gpm may be obtained. Where localized lenses of silt and clay occur, yields will be lower. Areas that have been mined for sand and gravel have been partially backfilled with washed out fines and exhibit considerably lower permeability than the original material. Areas of active or abandoned gravel pits are shown in Figure V-2 together with the potential yields of large diameter wells as predicted in the University of Nebraska study.

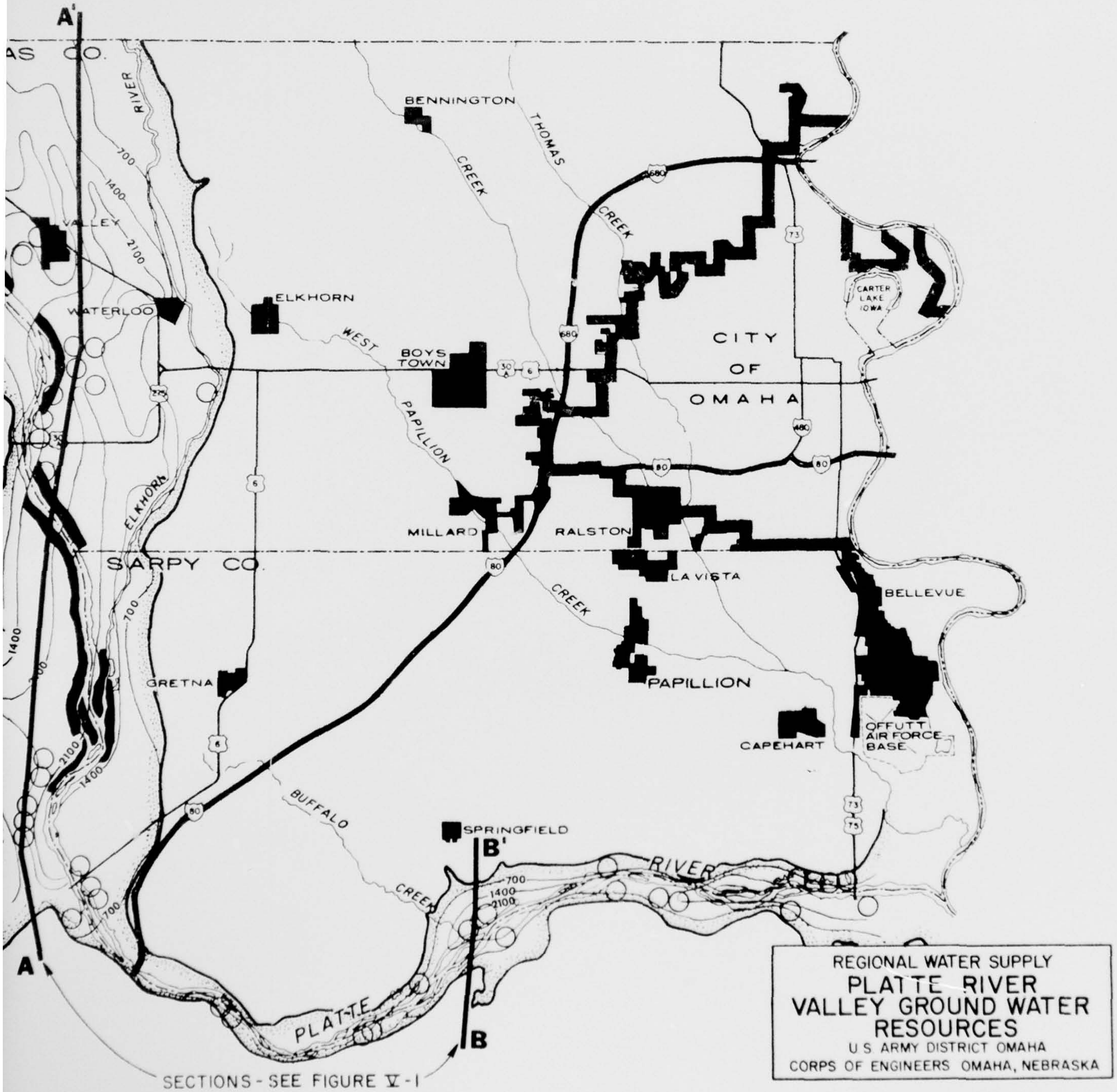
The Level "B" Study is a Federal and State interagency effort to formulate a comprehensive plan for the conservation, development, and management of the water and related land resources of the Platte River basin in Nebraska.

The Platte River Level "B" study will be submitted to the Missouri River Basin Commission in July, 1975, according to the study director, Mr. Carrol Hammon, and is subject to a 90-day review period prior to finalization. Preliminary results of this study were obtained through discussion with the Missouri River Basin Commission and personnel from the Corps of Engineers and USGS who are working on this study. Results from the Level "B" study cited in this section are tentative and subject to adjustment, but probably give a good overall indication of future water availability in the lower Platte.

Of particular significance are the tentative findings of the Level "B" study which predict that the lower Platte River would be "dried-up" by additional irrigation development for periods of one or more months during future dry years. This finding is based on preliminary data compiled by the Corps of Engineers in which recorded average monthly flows were reduced by stream flow depletions that would occur under two different assumed levels of irrigation development. The Alpha Plan assumes that the long-term historic rate of irrigation development would be continued into the future. Mr. Hammon had indicated that this plan reflects a minimum



LEGEND
700 LINE OF EQUAL YIELD POTENTIAL - gpm
POTENTIAL WELLFIELD LOCATIONS
ACTIVE AND ABANDONED GRAVEL PITS
SOURCE: GROUND WATER RESOURCES OF THE LOWER PLATTE VALLEY, MARLETTE AND BROGDEN, UNIVERSITY OF NEBRASKA - LINCOLN, 1971
A'
DOUGLAS CO.
RIVER
BENNINGTON
CREEK
VALLEY
2100
1400
700
WATERLOO
ELKHORN
WEST
BOYS TOWN
PAPILLION
ELKHORN
MILLARD
SAUNDERS CO.
SARPY CO.
GRETNA
BUFFALO
CREEK
SPRINGFI
B'
PLATTE
A
B
SECTIONS - SEE FIGURE V-1



A'
AS CO.
RIVER
BENNINGTON
THOMAS
CREEK
VALLEY
WATERLOO
ELKHORN
WEST
BOYS TOWN
PAPILLION
CITY OF OMAHA
CARTER LAKE IOWA
ELKHORN
MILLARD
RALSTON
SARPY CO.
LA VISTA
CREEK
BELLEVUE
GRETNA
PAPILLION
CAPEHART
OFFUTT AIR FORCE BASE
BUFFALO
CREEK
SPRINGFIELD
B'
RIVER
700
1400
2100
PLATTE
A
B
SECTIONS - SEE FIGURE V-1
REGIONAL WATER SUPPLY
PLATTE RIVER VALLEY GROUND WATER RESOURCES
U.S. ARMY DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE V - 2

2

rate of development under current water law and basin management practices. The Beta Plan assumes the accelerated rate of development which occurred from 1967 to 1973 would continue through 2020. This plan is purported to represent an upper limit to development rate.

Irrigation depletions were computed from estimated acreages and consumptive use rates by deducting the effective precipitation (portion of total precipitation that is used to meet the consumptive use requirement of the crop) from the total consumptive use requirement.

Streamflow depletions were computed using a mathematical model of the stream-aquifer systems in the Platte River basin. A detailed description of the stream-aquifer model will be contained in the completed Level "B" report. For present purposes it is sufficient to know that the model was used to solve the partial differential equation for unsteady flow through an unconfined aquifer with sources and sinks of varying strengths. The area to be modeled was discretized into a series of interconnected nodes. Water levels at nodes representing streams hydraulically connected to the aquifer were maintained at a constant elevation, this elevation corresponding to the water surface of base flow in the stream.

The model results gave the amount of flow into or out of the aquifer at each node and the corresponding water surface elevation. Based on the results, the Level "B" study has concluded that: (1) most of the water being withdrawn for irrigation under the present level of development has come from aquifer storage and stream flow depletion; (2) stream flow depletions have in fact occurred, but are generally within the accuracy of stream flow measurement ($\pm$ 5 percent); (3) sustained water level declines over large areas have also occurred, but are small. Localized areas of the Central Platte Subbasin however, have experienced declines of about 10 feet in the last 30 years.

Flows in the Platte River at North Bend and at South Bend which would remain during the years 1995 and 2020 were computed using the stream-aquifer model results by assuming that 1/12 of the total annual irrigation depletion occurs during any month. The depletions were made for each subbasin subject to the limitations that the depletion could not exceed available stream flow at any point. Since the maximum irrigation requirement would coincide with the low flow periods of summer, the actual case would be even worse than predicted. Preliminary results as computed by the Corps of Engineers are shown in Table V-2.

These results predict that under the Beta Plan flows in 2020 would be completely depleted during 6 months at North Bend and during 5 months at South Bend assuming a recurrence of 1949 to 1971 conditions. By 1995, the Platte River at both North Bend and South Bend can be expected to be dry for periods of at least a month in 1 out of every 10 years.

Under the Alpha Plan, the average monthly river flow was completely depleted only during the August 1955 drought for the 2020 level of development. By 1995 the river would probably be dry, but not for a month at a time, as under the Beta Plan.

TABLE V - 2

PRELIMINARY LOW FLOW DATA
FOR TWO PROJECTED LEVELS OF DEPLETION

1949 - 1971 PERIOD OF RECORD

LOW FLOW * MONTH & YEAR	BETA PLAN (MAX. DEV.)						ALPHA PLAN (MIN. DEV.)					
	PLATTE RIVER @ NORTH BEND			PLATTE RIVER @ SOUTH BEND			PLATTE RIVER @ NORTH BEND			PLATTE RIVER @ SOUTH BEND		
	Present	1995	2020	Present	1995	2020	Present	1995	2020	Present	1995	2020
AUG. 1953	1332	467	259	1997	923	686						
SEPT. 1953	1259	406	198	1594	546	314						
JULY 1954	908	50	0	1793	724	639	908	555	349	1793	1340	1084
AUG. 1954	1555	645	437	3149	2023	1780						
JULY 1955	1310	412	204	2262	1148	906						
AUG. 1955	442	0	0	519	0	0	442	96	0	519	73	0
SEPT. 1955	936	84	0	957	0	0	936	590	384	957	511	312
DEC. 1955	1413	296	37	1454	187	0						
JULY 1956	1111	259	51	2031	988	760						
AUG. 1956	1083	231	23	1498	485	266						
SEPT. 1956	1246	394	186	1161	216	1						
JAN. 1957	1206	200	0	1822	677	468	1206	749	500	1822	1290	991
AUG. 1957	1307	451	243	2215	1159	924						
JULY 1961	1275	293	85	2273	1075	833						
AUG. 1961	1539	584	376	2257	1091	852						
JULY 1963	761	47	47	1790	861	828	761	398	193	1790	1327	1064
AUG. 1963	1329	473	265	1853	784	545						
JULY 1966	1235	319	143	2381	1240	1056						
AUG. 1969	1318	201	74	2269	968	819	1318	861	499	2269	1712	1292
AUG. 1970	803	0	0	1188	228	208	803	346	66	1188	631	329
SEPT. 1970	1725	608	349	2186	889	611						
AUG. 1971	714	19	19	1283	403	338	714	257	19	1283	726	430
SEPT. 1971	1177	60	0	1432	130	5	1177	720	358	1434	875	455

* MONTHS WHERE ANY FLOW IS LESS THAN 500 cfs

If even the existing Platte River water supply sources for the cities of Omaha and Lincoln are to be protected, an effective management and "protected flow" system for Nebraska is an absolute necessity. Nebraska's vast underground water resource is being used faster than it can be replenished. Even with present levels of development, the Platte River was dry this summer at Chapman and existed as only a narrow ribbon of water at Grand Island and Columbus. The Loup River, one of the most even-flowing streams in the nation, was little more than a sandbar from Genoa to its confluence with the Platte.

Commenting on the conditions in the Platte this summer, Tom Pesek, Commission Biologist, stated "The reduction of flow below a certain quantity can result in both immediate and long-term adverse effects. Aquatic life perish and riparian habitat may be destroyed while recharge of aquifers and ultimately public and private groundwater supplies are reduced. The fish kill emergency declared this summer on the Platte River between Central City and Columbus exemplifies the immediate destructive effects of excessive unnatural streamflow depletion.

The present situation throughout Nebraska emphasizes the critical need for the establishment of a system of protected streamflows in

the state. Such a system, legally adopted and enforced, could insure the maintenance of minimum flows in perennial streams and, at the same time, allow reasonable surface water withdrawals for agricultural and other consumptive uses.

While uncontrolled agricultural development of ground and surface water can and will dry up the river during certain times of the year, the total effect on annual runoff from the basin is not as dramatic. Preliminary results of the Level "B" study suggest that on an average basis the Alpha Plan would result in a 17% reduction and the Beta Plan would result in a 29% reduction in present flows. Under the Beta Plan, the average annual flow at South Bend would be approximately 3700 cfs.

If storage space were available, flows could be stored and released as needed to supply agricultural and domestic requirements and maintain minimum flows for water quality and environmental requirements. Without such storage, further development of the lower Platte would be subject to interruption when it is needed most - during prolonged periods of drought. It would appear that any future development of the surface water in the lower Platte River would have to include sizeable storage facilities. Surface storage

could permit additional irrigation development while still maintaining minimum flows.

Minimum flow maintenance via use reduction by itself would restrict even current levels of water use during critical periods. Minimum flow criteria would presumably have to be applied to all users which would mean that when flow dropped to minimum, withdrawals from aquifers in lower reaches of Platte would have to be curtailed.

Platte River surface water quality is summarized in Table V-3.

Ground water sources in the lower Platte valley are intimately related to the surface water conditions since the two sources are hydraulically connected. Ground water depletions result in depletions to the surface water. The reverse is also true, particularly for wells adjacent to the river. The present Platte River well fields, which supply most of the water to the City of Lincoln and about 1/3 of the requirements for Omaha, have been investigated to determine the effects of low river flows. In 1972, W. G. Keck & Associates, Inc. concluded that the Omaha Metropolitan Utilities District Platte River well field required continual recharge

TABLE V-3

PLATTE RIVER ABOVE PLATTSMOUTH

Identification	Units	No. of Samples	Mean	Maximum	Minimum	Period of Sampling
Water Temp.	° F	383	54	90	32	61-70
Stream Flow	CFS	289	6,137	73,700	500	61-67
Turbidity	JU	379	504	7,800	14	61-70
Color	Pt-Co	242	8	50	1	61-70
pH	MG/L	388	8.1	8.8	6.9	61-70
DO	MG/L	375	9.7	14.0	2.7	61-70
5-day BOD	MG/L	360	4.1	26.0	0.2	61-70
Total Alkalinity	MG/L	391	167	360	60	61-70
Total Hardness	MG/L	290	181	400	36	61-70
Sodium	MG/L	14	56	72	40	62-70
Potassium	MG/L	14	9	11	8	62-70
Chloride	MG/L	389	66	250	10	61-70
Sulphate	MG/L	389	71	175	14	61-70
Fluoride	MG/L	11	0.43	0.60	0.29	62-70
Arsenic	MG/L	15	0.05	0.11	0.01	62-70
Barium	MG/L	14	0.10	0.19	0.02	62-70
Cadmium	MG/L	15	0.02	0.05	0.00	62-70
Chromium	MG/L	14	0.01	0.02	0.00	62-70
Lead	MG/L	15	0.03	0.05	0.00	62-70
Total Iron	MG/L	15	0.03	0.07	0.00	62-70
Manganese	MG/L	15	0.01	0.03	0.00	62-70

—Alkalinity and Hardness in $CaCO_3$ —

Source: Water System Master Plan, Metropolitan Utilities District, 1972.

from the river to produce at its projected capacity of 80 mgd. If the Platte goes dry, production from this well field would be immediately restricted and could only yield part of its rated capacity. The Lincoln well field, being in an extensive sand and gravel aquifer, could produce at a rate of 130 mgd for 19 days under conditions of zero river flow. After 19 days the yield would be reduced considerably until the aquifer is recharged from surface water.

There is an estimated 35.1 billion cubic feet of aquifer underlying a site between Highways 64 and 30A and the Platte and Elkhorn River. In a report entitled "Ground Water Resources of the Lower Platte Valley," Professor R. R. Marlette states that this site is capable of providing 150 mg of groundwater per day. W. G. Keck & Associates have estimated that this site could provide 135 mgd for 61 days without recharge from the river. This site would operate as a natural reservoir in that withdrawals from storage could provide sustained flows during drought periods. The aquifer would be quickly recharged when surface flows resumed.

Other potential ground water sources which were investigated in the 1972 study on Long Range Comprehensive Water System Master Plan for the Metropolitan Utilities District include the Springfield

site and the South Platte site. The Springfield site extends from the existing Platte River well field site to the west for a distance of approximately five miles. Most of the river frontage along the site has been used as a source of gravel, leaving vast deposits of "washed out fines" to inhibit the construction of a well field. Only two sections of the entire site were found to provide significant quantity potential. One section is on the far upstream end of the site and the other is located on the downstream end just upstream from the existing Platte River well field. The W. G. Keck & Associates preliminary estimate of yields from these two sites was approximately 40 mgd from the westerly river frontage and 21 mgd from the easterly frontage. The South Platte site is immediately upstream and across the river from the present Platte River well site. This site has also been used as a gravel source. Result of such operations is replacement of finer grained materials into an area from which sand and gravel has been extracted. Permeability of the finer material is less than the original sand and gravel aquifer. Wells in the fines could extract limited amounts of water, however, adjacent undisturbed materials would produce much more favorable yields.

Of some concern is the deposition of sediment during low flows

causing a decrease in aquifer recharge.

However, one of the prerequisites for location of a large well field aimed at inducing river recharge is that the main channel of the river flow adjacent to the proposed area. Such a condition reasonably assures the availability of water for recharge and also for periodic scouring of the river bed.

Also bed material in the Platte River is fairly uniform with all material greater than .125 mm and with 90% less than 1.00 mm. Normal sediment transport should be sufficient to keep the bed material mixed in the channel to maintain the necessary recharge rates.

Other Supply Sources

Summaries of alternative water sources presented herein are taken from the respective county and areawide Comprehensive Water and Sewer Plans prepared by:

Harrison County
Harold Hoskins and Associates, Inc.
Lincoln, Nebraska

Mills County
Anderson Engineering Co.
Des Moines, Iowa

Pottawattamie County
B. H. Backlund and Associates
Omaha, Nebraska

Nebraska Region 4
(includes Cass County)
Leo A. Daly Company
Omaha, Nebraska

Nebraska Region 5
(includes Washington County)
Richard M. Wonziak
Fremont, Nebraska

Harrison County is divided topographically by rugged dissected uplands and flat, sometimes swampy lowlands. The lowlands occupy approximately the western one-third of the county while the uplands account for the remaining area. The Missouri River forms the western border of the county and all major rivers in the county drain into the Missouri in a northeast to southwest trend. Several smaller drainages in the county also trend northeast to southwest. The major rivers are: Solider River, Allen Creek, Willow River, Pigeon Creek, Mosquito Creek, and the Boyer River.

The characteristics of stream flow and precipitation for any area are closely related. In Harrison County the normal annual precipitation is 26 - 28 inches. The average warm season precipitation (April through September) is 20 inches or about seventy-five

percent of the annual total. It is expected that stream flow, accordingly, will be greater during warm months and much less in the other months.

Studies of the disposition of precipitation in rural areas show that approximately seventy percent of all precipitation is lost by evaporation. Generally, ten percent of the total precipitation percolates into the soil, but this amount varies with the season, the soil type, and the crop cover. The remaining twenty percent occurs as runnof and is dispersed by rivers.

In urban areas, the rates of precipitation runoff are considerably greater because of paved surfaces and impermeable building materials.

Natural lakes in the county are found in the lowlands near the Missouri River. These lakes are used for recreational purposes. A few artificial lakes have been constructed in the rural areas mainly to provide erosion control and water for livestock.

Groundwater supplies are dependent upon the character and arrangement of subsurface deposits. In Harrison County, four basic categories of deposits make up the subsurface. They are: (1) alluvium, (2) loess, (3) glacial drift and (4) bedrock. Alluvium consists of interlayered beds of clay, silt, sand and gravel that have been deposited by the action of water. The loess of Harrison County is composed of silt-size fragments that have been carried and deposited by the wind. Glacial drift consists of deposits of unstratified sandy clays, gravelly clays, sands and gravels that have been brought into the area and deposited by glaciers. The term "bedrock" encompasses materials of several different geological origins that have been consolidated or hardened during their history. Rock units underlying the study area include shale, limestone, sandstone, gypsum, dolomite, siltstone and several types of igeneous and metamorphic rocks.

The movement of groundwater through subsurface materials is quite variable. Limestones, dolomites,and other massive type rocks

transmit water through fractures, joints, and solution cavities. Water moves and occurs in the voids between grains of sand, gravel, sandstone, and conglomerate. Shale is very impermeable and usually does not transmit enough water to be considered an important aquifer.

The water supplies of Harrison County are obtained from alluvium, glacial drift, and bedrock. Alluvial sands and gravels are located in the flood plains of the rivers and in the associated terraces. Drilled wells using this source account for the bulk of municipal water supplies in Harrison County. Yields vary from a few gallons per minute to as much as 750 gallons per minute depending mainly upon the thickness and grain size of the water saturated aquifer. The quality of water from alluvial sources is generally only fair,and treatment is required to provide a good municipal supply.

Potential sand and gravel aquifers are located at various positions in the glacial drift: (1) at the contact between the overlying loess and the drift, (2) at the contact between the two drift sheets found in Harrison County, and (3) in buried channels that were cut into the bedrock surface just prior to glaciation. The glacial sands and gravels are not as thick as the alluvial deposits and groundwater

yields are much less, usually 5-20 gallons per minute. The quality of this type of water is poor and treatment is required to provide a good supply for domestic purposes.

Groundwater is taken from bedrock units by only one community in Harrison County, Woodbine. At this location, the Dakota Sandstone is the aquifer and it produces approximately 200 gallons per minute. This supply is of relatively good quality in comparison to other bedrock water in the region. In the early part of this century, several Harrison County communities drilled deep wells for their supplies, but most of the water was highly mineralized and in time chemical precipitates sealed up the well screens.

Mills County. Water is currently supplied from either ground or surface water sources in Mills County. There are ample sources of raw water in the form of either surface water or groundwater. The potential usable quantity of surface water exceeds that of groundwater, but the ease of obtaining high quality groundwater has been most extensively utilized. Glenwood is currently the only town obtaining their raw water supply from surface sources namely Keg Creek. The wise dependence on groundwater is partially due to the stability of the groundwater supply. It is possible for the water table to go down over extended periods of drought, but substantial fluctuations in the water level have not been experienced.

Major surface water features in Mills County include the Missouri River along the west border of the County, and the West Nishnabotna River traversing through the east-central portion of the County. Keg Creek which flows into the Missouri River and Silver Creek, which flows into the West Nishnabotna River are also major surface water drainage features. These surface waters are used for municipal water supply (Glenwood), recreation, agricultural uses, and fish and wildlife propagation.

The two principal water-yielding rock units in Mills County are the alluvium (surficial deposits), and the Dakota Sandstone of Cretaceous Age. In addition, yields of ten to twenty gallons per minute are available from relatively thin limestones and sandstones that are interbedded with the thick shales of the Pennsylvanian System which exists in most of Mills County. The water, however, generally, is highly mineralized. Occasionally, yields of as much as fifty gallons per minute of fair to good quality water can be produced from channel sandstones that occur locally in the Pennsylvanian.

The most important source of water in Mills County is the surficial aquifers consisting of alluvium deposits underlying the flood plains and terraces of the Missouri River and the West Nishnabotna

River. The water bearing materials underlying these valleys consist mainly of fine to course sand and gravel and some inter-stratified clay and silt that were sorted and deposited by glacial melt waters. The thickness of these alluvial deposits are from 100 to 160 feet along the Missouri River, and from thirty to seventy feet along the Nishnabotna. The deposits thin out and grade into colluvium near the bluff lines. Individual wells tapping the alluvium along the Missouri flood plain are capable of pumping large quantities of water. There are presently more than a dozen wells in Mills County located in this flood plain that are being used for supplemental irrigation. It is not unusual for this type of well to produce 1,000 to 1,500 gallons per minute.

Glacial drift is also a source of water supply for numerous farms and rural homesteads. The drift consists principally of silt, clay, sand and gravel. These wells may be from fifteen to twenty feet or may go as deep as 250 feet. Generally, these wells yield only a few gallons a minute.

The Dakota aquifer exists in a small portion of the northeast corner of Mills County. Although most of this aquifer is in northwest Iowa, there is a portion that dips down into Mills, Montgomery and Page Counties. The Dakota aquifer generally can be counted on to produce sufficient water for all rural and many municipal

requirements. Even where the aquifer is only moderately thick, many wells have been developed to yield 50 to 100 gallons per minute. At Red Oak, where the Dakota is thin but apparently is recharged readily, yields of up to 1,000 gallons per minute are available from the Dakota aquifer.

Pottawattamie County. The streams of Pottawattamie County are tributaries of the Missouri River. The major streams, Honey Creek, Pidgeon Creek, Mosquito Creek, Keg Creek, Silver Creek, West Nishnabotna River, Graybill Creek and Walnut Creek, flow in a southwestward direction. These aforementioned major streams and their tributaries drain approximately 675 square miles or 73.5 percent of the total county area.

The valleys of major streams are the most desirable areas for water developments. However, the danger of floods must always be considered in proposing flood plain developments. In most cases the upper ends of a watershed will be less susceptible to heavy siltation than major tributaries; however the upper end of the watershed has less potential for a firm water supply. Such factors are important in the selection of reservoir sites, as they affect the life expectancy of the project.

Pottawattamie County has an annual precipitation normal of 31.78 inches, of which about 73.5 percent falls during the 6 months from April to September, inclusive. This leaves a very low amount of precipitation (26.5 percent) from October to March. The low flow of a stream is a limiting factor on the beneficial use of the water it carries, thereby making it an unreliable single source of supply.

It is important to note that streamflow distribution is unfavorable from the standpoint of using surface water for irrigation. The period when much water is needed for irrigation is during mid or late summer. At this time stream flow is generally lowest or, at best, less than 25 percent of the average for the year. This might mean that it would be necessary to store water in reservoirs during the spring months when it is most plentiful.

Low streamflow from August through January is often the bottleneck in surface water supply for industry. Industrial plants find it necessary to set their maximum requirement at the low stage or to supplement this critical period by building storage facilities.

Stream pollution and disposal of industrial waste are problems that may occur during periods of low flows. These problems will become more acute with increased population and industrial expansion. It appears, however, that there is adequate surface water for sanitation in most areas if storage could be provided to supplement low flows.

Natural lakes are rare in the study area owing to the maturity of the topography. Farm ponds or reservoirs, however, are an important source of water to most residents of Pottawattamie County. The number of farm ponds constructed in Pottawattamie County as of 1964 is 572 and is being used by 308 farms. The total area of the ponds is 619 acres.

Cass County. Water is available from the Platte and Missouri Rivers in Cass County. The quantity is high although treatment is required to make this source potable.

The main potential source of water is located in the lower Platte Valley aquifer. This is located in the northern quarter of Cass County. This aquifer is recharged by the Platte River which originates at North Platte, Nebraska, with the junctions of the North Platte and South Platte Rivers. The North Platte River originates

along the Wyoming-Colorado border and flows north through Wyoming, making an easterly turn about midway across the state and flowing toward its confluence with the South Platte. The North Platte drains the Northern Front of the Snowy Range Mountains in Wyoming and Colorado. The South Platte originates in the Rocky Mountains, southwest of Denver and drains the eastern front of the Rocky Mountains. It flows northeast across Colorado and Nebraska to its confluence with the North Platte River at North Platte, Nebraska.

The Elkhorn River and the Salt Creek drainage basins aid in the ground water recharge of the lower Platte Valley Aquifer.

The southeast corner of Cass County contains a small extension of the Missouri River Aquifer which is recharged by Weeping Water Creek and its tributaries.

The quantity of water derived from the Lower Platte Valley aquifer can be testified to by the location of well fields serving the two largest metropolitan areas in Nebraska. These are Lincoln's water supply located at Ashland and Omaha's supply located west of La Platte on the Platte River. The shallow wells rely mainly upon small layers of

sand fed by surface water recharge. The deep wells generally penetrate to the Platte Valley aquifer for their source of supply.

In Cass County, the majority of the wells are shallow with deep wells existing in the northwest 1/4 of the county. The average shallow well depth is 50 feet. Seasonal water shortages are prevalent because of this. (Many farmers must haul water from nearby urban communities to meet their large water demands).

Water on rural farms is drawn mostly from surface wells (less than 100 feet) which are subject to contamination by cesspools, land disposal. and ditch discharge of sewage from farmsteads. The need for an adequate and safe water supply for rural residences should have priority over any other considerations.

The cost of treatment facilities for these communities would have to be compared to costs associated with rural water district formation. The formation of rural water districts centered upon these communities would supply water of good quality and quantity. Existing facilities could be ratined for emergencies.

Washington County. Major water courses bordering Washington County are the Missouri on the east and the Elkhorn River on the southwest. All communities in the county are served by wells although only one major area of the county has aquifer capable of supplying large quantities of water. In the northeast corner of the county

from Herman to the Missouri River the existence of 20 irrigation wells with capacities of 1000 gpm or greater indicates an aquifer of good capacity underlying the area.

Nebraska is divided into 13 areas where the groundwater conditions are similar. There is a transition of general conditions from one region into adjacent regions and the boundaries are flexible and subject to minor adjustments.

Most of Washington County is classified as Area 10 - Northeast Nebraska Glacial Drift Region. Yields from wells in the glacial till area are small to negligible and the water is highly mineralized. Where thick deposits of Pliestocene sand and gravel are not present, adequate supplies are difficult to obtain except by drilling into the deeper Dakota Sandstone. The Dakota is tapped by many domestic and stock wells in portions of the region where it can be reached at shallow and moderate depths. Other bedrock formations in this area are generally poor sources of water.

Land bordering on the Missouri River is classified as Area 3 - Missouri Lowland Region. Large yields can be obtained from wells in much of this area. Since pumping from wells near the river induces seepage from it, large quantities of water could be taken without

causing a progressive decline in the water level. A general lowering of groundwater levels would provide storage for part of the floodwaters that currently pass through this area. Because this area is close to the more populated part of the state, it is expected that a much greater demand and development of its water supply potential will be made for industrial and municipal use. The high iron content of water in this area requires treatment to be satisfactory for many uses.

If the amount of irrigation using groundwater is greatly increased, detailed studies should be made to determine the perennial safe yield of the underground reservoir.

This study would include water table contour maps, long-term periodic water-level measurements in observation wells, geologic mapping, preparation of maps showing the static water level and the saturated thickness of the aquifer, determination of the transmissibility and storage coefficients of the aquifers, streamflow measurements and chemical analysis of the water, noting ultimate changes in quality. According to the Conservation and Survey Division of the University of Nebraska, much of this has already been done.

In general, Nebraska's ground water which occurs at comparatively

shallow depths is of good quality for almost all uses, but is moderately hard and averages about 400 parts per million of total dissolved solids. Concentration of salts is highest in parts of eastern Nebraska where wells are either developed in materials of lower permeability or in some of the Cretaceous bedrock formations. There is a tendency for an increase in iron and manganese content in the eastern portion of Washington County.

Total streamflow appropriation indicated by water rights on file is quite small. These rights are mainly for irrigation use. Streams and lakes throughout the area are used for livestock water.

Major sources of pollutants in the region are sediment, herbicides and pesticides, nutrients from commercial fertilizer, and wastes from barnyard and feedlots.

A major pollutant of streams from agriculture is sediment from soil erosion. This causes clogging of stream channels, destruction of fish habitat, and reduction of recreational value of surface waters.

The confined feeding of livestock has increased greatly in recent years. While livestock feeding has been increased, use of commercial fertilizers have displaced the use of animal wastes for fertilizing soil.

These two concurrent developments have caused the disposal of animal wastes to become an item of cost rather than an asset. Studies indicate that the quantity of pollution contributed by confined livestock feeding is largely a function of area of feedlots rather than the numbers of livestock. Runoff from feedlots reaching streams presents a greater pollution problem than the same amount of runoff from cropland due to its higher coliform count and its higher biological oxygen demand (BOD).

Many feedlots are located near water courses to facilitate waste disposal. A damaging effect of this practice has been to "slug" local reaches during times of large runoff, and fish kills have resulted in localized stream reaches.

In order to improve surface water quality, the greatest need is to reduce the quantity of sediment entering streams. This can be accomplished by more use of land treatment practices such as terracing and grassed waterways on cropland, and proper grazing on grasslands.

There is a need to reduce the quantities of nitrates and phosphates entering streams resulting in over-enrichment of the water. Proper management of feedlots and proper use of chemical fertilizers will reduce the leaching of nitrates into groundwater which eventually enters

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WATER AND RELATED LAND RESOURCES MANAGEMENT STUDY. VOLUME V. SU--ETC(U)
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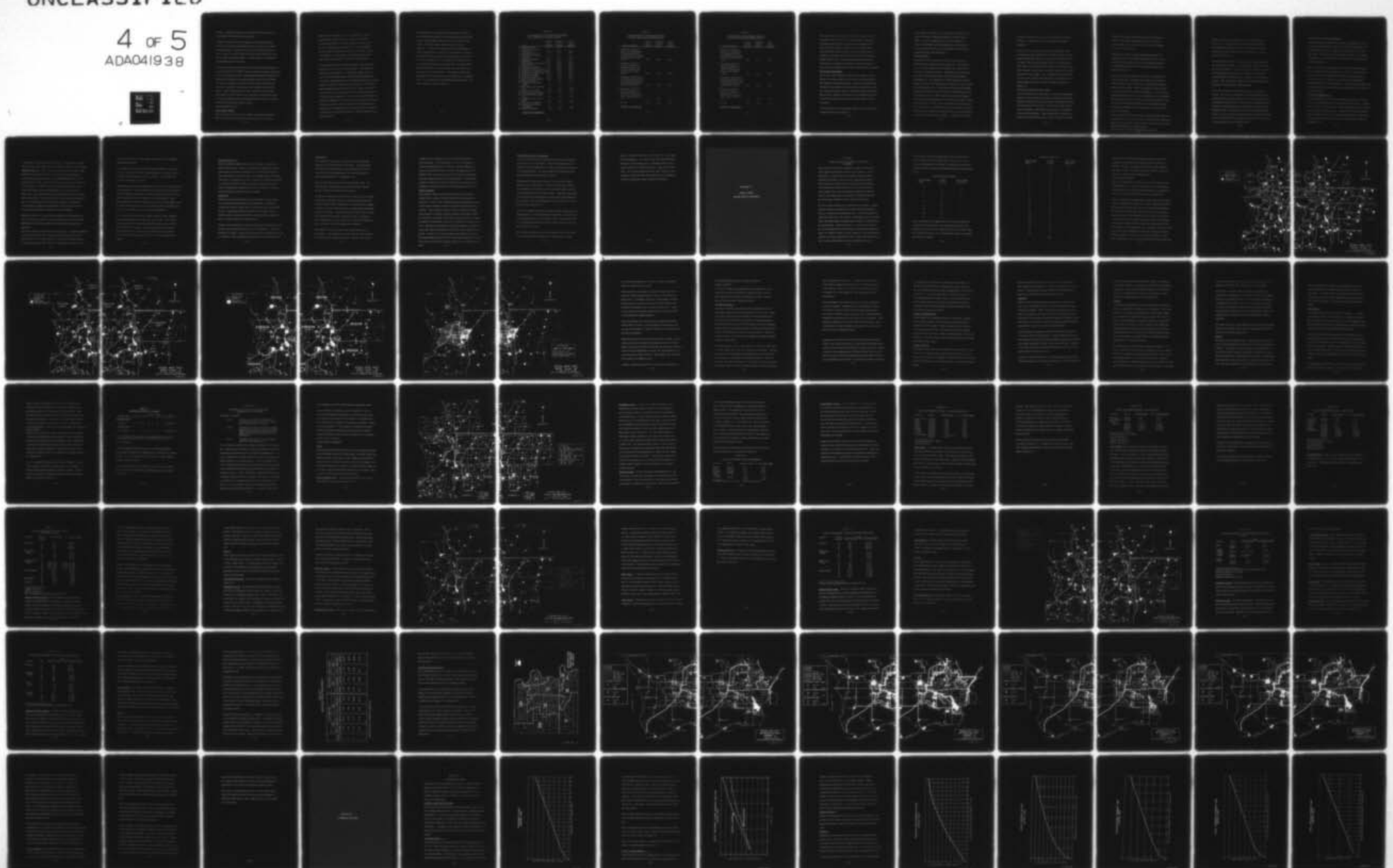

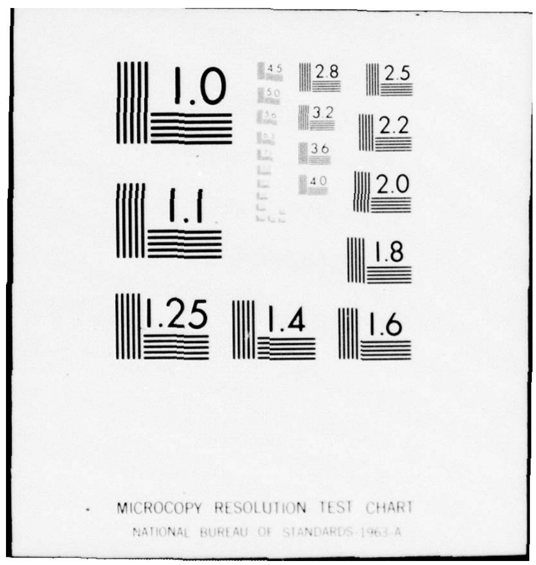
1.0
1.1
1.25
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1.6
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2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

streams. Sediment reduction into streams will reduce the amount of phosphorous which enters surface waters.

Continued research is needed to determine economically feasible practices which will permit proper disposal of wastes from confined feeding operations. Examples under study are holding ponds and lagoons. There is a need to control the location and design of new feedlots to reduce the pollution hazard. In some instances, relocation of established feedlots is desirable.

Research is being conducted by the University of Nebraska and Agricultural Research Service (USDA) relative to pollution of surface and groundwater by livestock in feedlots. The Nebraska Department of Health is initiating the development of sanitation quidelines for livestock feedlots. Performance standards will follow as research data and financial resources are expanded. The first step was to register feedlots in Nebraska. Feedlots which have more than a specified head of animals, those which are within 500 feet of any watercourse, and any other feedlot having a significant water pollution potential are required to register with the Nebraska Water Pollution Council.

WASTEWATER RECYCLE

Potable Water Supply

Because the pressure on our water supplies is growing exponentially while the amount of naturally-occurring fresh water is fixed, there

appears to be a growing need to reuse wastewater, even for drinking water. There may be some places of such water scarcity that this practice may be required, but such is not the case in Omaha-Council Bluffs area. Recycling of highly treated sewage treatment plant effluents for some uses, such as cooling water, toilet flushing, and lawn watering, may be both feasible and desirable, but not for drinking purposes.

In many of the waterborne outbreaks that have been reported in recent years, the virus, infectious hepatitis, was introduced through a cross connection or contaminated supply source of raw or nearly undiluted sewage and transmitted through the water system. Although there have been significant advances in virus-detection techniques, they are still not perfected. Even tertiary waste treatment processes cannot obtain an overall virus reduction of 100 percent. Also advanced waste treatment processes to be used for direct wastewater recycle are so complex that they are subject to breakdown to one or more of their unit processes and not 100 percent reliable. The Environmental Protection Agency has issued a policy statement that at the present time there should be no direct reuse of advanced wastewater treatment effluents for domestic purposes.

The acceptance of reclaimed water by the public is a matter of considerable importance in view of growing discussion about direct reuse of sewage effluent as a source of domestic water supply. To examine public attitude toward reclaimed-water use, a survey was made in California communities in which reclaimed water is used for various purposes. The purpose of the study was to measure attitudes toward various specific uses of reclaimed water. One half of the respondents were from communities where use is being made of reclaimed water, while the other half were from similar sized communities not having access to reclaimed water. The primary attitude of the respondents for 25 selected uses of reclaimed water are listed in Table V-4, Respondents recommendations regarding uses of reclaimed water are shown in Table V-5.

Table V-4

PERCENTAGE OF RESPONDENTS OPPOSED TO 25 USES OF RECLAIMED WATER

Use	Project (479)* percent	Nonproject (493)* percent	Total (972)* percent
1. Drinking water	56.6	56.2	56.4
2. Food preparation in restaurants	56.2	55.8	56.0
3. Cooking in the home	53.2	55.7	54.5
4. Preparation of canned vegetables	54.3	53.9	54.1
5. Bathing in the home	37.6	39.7	38.7
6. Swimming	22.4	25.0	23.7
7. Pumping down special wells	25.7	20.8	23.2
8. Home laundry	21.3	24.2	22.8
9. Commercial laundry	19.7	24.1	21.9
10. Irrigation of dairy pasture	14.2	14.0	14.1
11. Irrigation of vegetable crops	14.9	13.2	14.0
12. Spreading on sandy areas	14.3	12.2	13.3
13. Vineyard irrigation	14.5	11.3	12.9
14. Orchard irrigation	10.9	9.3	10.1
15. Hay or alfalfa irrigation	8.6	6.5	7.5
16. Pleasure boating	7.9	6.7	7.3
17. Commercial air conditioning	7.5	5.5	6.5
18. Electronic plant-process water	6.1	3.7	4.9
19. Home toilet flushing	5.4	2.2	3.8
20. Golf course hazard lakes	3.1	3.0	3.1
21. Residential lawn irrigation	3.5	1.8	2.7
22. Irrigation of recreation parks	3.5	1.6	2.6
23. Golf course irrigation	2.7	0.6	1.6
24. Irrigation of freeway greenbelts	1.9	0.6	1.2
25. Road construction	1.5	0.2	0.8

*Number of respondents

Table V-5

RESPONDENTS' RECOMMENDATIONS REGARDING USES OF RECLAIMED WATER

Recommendation	Project (479)* percent	Nonproject (493)* percent	Total (972)* percent
1. Wastewater should be given a very high degree of treatment and used for any purpose including uses that involve human contact.	48.0	45.6	46.8
2. Wastewater should be given a high degree of treatment and then reused for purposes that do not involve human contact.	37.2	39.1	38.2
3. Wastewater should be given a moderate degree of treatment and then reused for purposes that do not involve human contact.	11.8	13.8	12.9
4. Wastewater should be given a low degree of treatment and then released into the ground or ocean without further reuse.	2.1	0.8	1.4
5. No data	0.8	0.6	0.7

*Number of respondents

Table V-5

RESPONDENTS' RECOMMENDATIONS REGARDING USES OF RECLAIMED WATER

Recommendation	Project (479)* percent	Nonproject (493)* percent	Total (972)* percent
1. Wastewater should be given a very high degree of treatment and used for any purpose including uses that involve human contact.	48.0	45.6	46.8
2. Wastewater should be given a high degree of treatment and then reused for purposes that do not involve human contact.	37.2	39.1	38.2
3. Wastewater should be given a moderate degree of treatment and then reused for purposes that do not involve human contact.	11.8	13.8	12.9
4. Wastewater should be given a low degree of treatment and then released into the ground or ocean without further reuse.	2.1	0.8	1.4
5. No data	0.8	0.6	0.7

*Number of respondents

The results of the research indicate that over 50 percent of the respondents did not accept using reclaimed water for purposes involving personal contact. The data strongly suggest that the public is not yet ready for intimate uses of reclaimed water. The data indicate that the public is not in favor of low level of treatment of wastewater and its discharge into the environment without further reuse. Thus the finding would indicate that a high degree of treatment of wastewater and then reuse for purposes not involving significant personal contact would be acceptable.

Non-Potable Water Supply

Use for home toilet flushing, domestic lawn irrigation, and irrigation of recreation parks, golf courses and freeway greenbelts falls within the low opposition group. Experience has shown that the degree of wastewater treatment required to meet these water use requirements would require a chlorinated effluent having less than 30 mg/l of BOD and suspended solids. Wastewater plant effluents of lesser quality create an odor problem and have been unacceptable.

Use of wastewater as a non-potable supply source in a dual water system is discussed in Chapter VI.

Land disposal of wastewater is an alternative considered in the Regional Wastewater Management Study for Omaha-Council Bluffs. As well as supplying water for crop irrigation, recharge of groundwater and flow augmentation in the Platte River are possible beneficial uses of wastewater treated by land disposal methods in the Todd Valley.

STORM RUNOFF

From 1954 to 1963, an average of 80,700 acre feet per year flowed out of the Papillion Creek drainage basin. This amounts to 3.8" of runoff from the entire drainage area or about 13.6% of the 28" of annual precipitation. Significant use of water from this source would be dependent on storing runoff from large drainage areas. The Papillion Creek flood control dams would appear to offer the only opportunity for utilization of excess runoff in the metropolitan area. The 20 planned reservoirs in the Papio valley would control runoff from 47% of the total drainage basin or about 187 square miles. Their combined conservation storage is 47,000 acre feet or approximately 2/3 of the average annual runoff after correction for the increased evaporation loss from the reservoir surface area. It's possible that some of the larger reservoirs could be used to supplement existing water sources, particularly if a dual water system concept is adopted. In addition to the 47,000

acre feet of conservation storage, there would be an additional 76,000 a. f. of flood control storage available in the Papio watershed.

In June of 1971, at the time of writing the Omaha MUD report, an inquiry was made regarding the availability of water from the proposed Papio dams and lakes for the purpose of municipal water supply. These proposed facilities are to be constructed for flood control, recreation and water quality. Unless this priority can be changed, it would appear that there would not be any water available for water supply. Use of stormwater runoff collected in storm sewer systems and treated prior to discharge as a non-potable supply source in a dual water system is discussed in Chapter VI.

WATER TREATMENT PLANT WASTE

The Environmental Protection Agency is currently evaluating its position on water treatment plant waste discharges with effluent standards expected to be announced shortly. Discharge limitations will require some form of solids recovery from waste streams such as lagooning, recalcination of lime sludge, or mechanical dewatering and landfilling. Lagoon supernatant or liquid waste streams from dewatering processes can be returned to the water

treatment process preventing the necessity of discharge to a stream. Thus effluent standards will be met by means of zero discharge and recovery of water will reduce withdrawal from the raw water source.

Special waste streams containing high dissolved solids concentrations such as ion exchange regenerate brines or reverse osmosis waste concentrate present solids handling problems. Fortunately these processes are not used on any large scale within the study area.

A variety of possible beneficial uses for water treatment plant waste sludges exist. Dumping of lime sludges in the sanitary sewer may have positive effects on the settleability and dewaterability of sewage sludges. However plugging of sewers and filling of digesters with inert solids are problems. Use of recovered solids in building materials or as soil conditioners are possibilities. Existing studies of water treatment waste disposal within the study area and surrounding vicinity indicate land reclamation through lagooning or landfilling of waste solids is the best method of ultimate sludge disposal.

At the present time all water treatment plants within the study area discharge wastes to a receiving stream. MUD's Florence Plant and Platte River Plant and the Council Bluffs' Plant discharge filter backwash and softening plant coagulant sludges.

At the Platte River Plant, filter backwash goes to the

Platte River while lime sludge wastes are pumped to the Missouri River. At the Florence Plant and Council Bluffs Plant, presedimentation sludge, consisting of settled heavy suspended materials, normally without the chemical additives, is also directed back to the river.

Of the methods for disposal of softening plant sludges, lagooning has been the most common. A few plants have installed facilities for lime recalcination. Lime recalcination is a process comprised of sludge thickening, dewatering by centrifuge or vacuum filter, flash drying and converting calcium carbonate to a reusable lime product. Other plants have implemented sludge thickening and dewatering and are hauling the sludge to landfill.

The method of handling filter backwash water is to practice recycling. This can be accomplished at the Florence plant by intercepting the filter backwash discharge lines from the existing filters, directing the backwash water to a large wet well pumping station to handle the variable discharge and pumping the flow to the presedimentation basins. At the Platte River plant filter backwash would be held in a recovery basin and pumped back to the upflow-clarifiers. At Council Bluffs the filter backwash would be held in a recovery basin and pumped back to the flash mix basins.

POWER PLANT HEATED DISCHARGE

Tremendous quantities of water are used for cooling purposes in electric power generation plants. Within the study area, power plant cooling water requirements are roughly ten times greater than all other water needs. Except for some recirculation in winter for ice control, cooling water is returned directly to the Missouri River having served no additional purpose.

There are two basic considerations for using cooling water discharge in lieu of traditional water supply sources: First, if the heat energy itself can be put to beneficial uses and second, if subsequent use of the water can serve to dissipate the heat and thus prevent possible thermal pollution of the receiving waters. Reuse potentials of power plant cooling water range from low quantity, special purposes to system-wide municipal supplies.

Total System Supply Source

On a system wide basis, power plant cooling water could, after proper treatment, be introduced into the existing distribution system. Temperatures above 85° F - 90° F, however, would require extensive system modifications involving storage, meters, customer connections and support of plastic pipe where used. For new distribution systems, engineering designs could incorporate these factors resulting in minor additional development costs.

A simulation of using power plant discharge as a municipal water supply source for the City of Seattle has been conducted. (Hansen, Knoll and Mar, AWWA Journal, Mar. 1973). The study reported that if the water supply temperature is increased from 65 to 90° F and the household piping is such that warm-water needs may be satisfied without passing the water through a water heater, energy savings for water heating may range from 25 to 50 percent. In Seattle, the reduced energy needs would result in customer savings of several million dollars a year in lower electric power bills. The reduced energy needs would additionally reduce cooling water requirements. If river discharge of cooling water were prohibited, the cost of cooling towers or cooling ponds would also be eliminated. The study did not explore the acceptability of receiving warm water at the tap by industrial water customers or the general public.

Within the study area, a more limited yet highly practical application of this concept concerns the use of heated discharge from the North Omaha OPPD plant by the Florence MUD water treatment plant during winter operations.

These two facilities are less than one-half mile apart. If proposed expansion of the Florence plant occurs south of the present location, these two facilities will be in even closer proximity. Rather than expanding capacity of the current Florence Plant intake or constructing a new intake, water

could be diverted from the power plant cooling discharge to supply the additional water needs.

In the winter, the heated water would eliminate difficulties caused by freezing. Currently the Florence Plant employs a cumbersome process of fitting styrafoam blocks over water surfaces. This technique has been less than totally successful.

A higher water temperature would also serve to increase flocculation and filtration efficiency. A study conducted by the University of Pennsylvania in 1962 concluded that treatment cost savings (chemicals) of up to 4 percent could be obtained for each 10 degree F rise in temperature. Power plant cooling water discharge could also be used as a partial supply source during the other seasons of the year. However, public acceptability may be low for even slight increases of tap water temperature.

The current intake at the Florence Plant averages 52 mgd; expanded facilities will increase this to about 120 mgd by 1995. If the cooling water requirements of the North Omaha Power Plant remain constant and 50 percent of the Florence treatment plant intake is provided by power plant discharge, 12 percent of the heated discharge would be diverted from direct return to the river to use in the municipal water supply.

Special Purpose Uses

Numerous potential applications exist for utilizing the heated wastewater of power plants. However, relatively low temperatures, power plant siting, and current technology serve to constrain the degree to which this potential can be realized. Several applications are summarized below. It is important to realize, though, that in general the quantities of water involved are small or negligible compared to the total amount of power plant cooling waterused in the study area. Reduction of thermal pollution would therefore be minimal.

Agriculture

Studies have indicated that growth rates and yields for certain crops can be increased through elevated soil temperatures. Methods for retaining the moisture (heated water) in the soil have not been devised, however. Regarding greenhouse production, the manager of one of Omaha's largest floral greenhouses has stated that lower temperature water is actually preferred for plant watering.

Irrigation with heated water could also provide benefits through increased growing seasons and protection against early killing frosts. During an experiment in Oregon, crop frosting was prevented at temperatures as low as 27 degrees F when sprinkling was provided by water at 95 degrees F.

Aquaculture

Increasing water temperature can increase the rate of growth, ultimate size of certain fish and crustaceans. The metabolism, respiration and oxygen demand of fish and other aquatic life increase with increasing temperature with respiration approximately doubling with a 10° C temperature rise.

Fish are more efficient converters of protein than cattle. Current shortages of feed grain products could therefore enhance the role of fish in the American Food industry.

At Fremont, Nebraska (just outside of the study area), power plant cooling water discharge is used by a commercial fish farm in the raising of catfish and St. Joseph's fish. Except under heavy loading conditions, all of the heated discharge (4,500 gpm) goes through the fish farm's raceways. Water temperature is in the 72-82° F range when discharged by the power generating facility. According to power plant operators, water temperature remains essentially constant, even after treatment (settling) by the fish farm.

Desirability of the use of nuclear power plant cooling waters is questionable. Any radioactive waste present in the water would be concentrated by fish feeding in the water. Missouri River water

contains several substances in excess of limits desirable for fish propagation. According to Hart, et. al. in "Evaluation of Toxicity of Industrial Wastes, Chemicals and Other Substances," mean concentrations of sulfate, calcium, and magnesium in the Missouri River exceed levels present in 95 percent of the nations waterways supporting good game fish populations. Elevated temperatures would also increase the effect of trace amounts of toxic substances sometimes present in untreated Missouri River water.

Waste Treatment

The capacity of sewage treatment plants utilizing the activated-sludge process could be increased through elevated sewage temperatures. An 18° F rise in temperature (typical differential across a power plant condenser) would nearly double the biochemical reaction rate. This increased efficiency could be obtained by actually using sewage as a coolant, passing it through a power plant condenser just prior to treatment. The problem of grease and micro-organism builld-up on the inside of the tubes would have to be solved, however. Additionally, the amount of municipal wastewater available to a particular plant would likely be less than the total cooling water required. In such a case, a dual cooling system would be necessary. Decreasing oxygen solubility with increasing liquid temperature would also limit the practicality of heating sewage prior to biological treatment.

Space Heating and Air Conditioning

Little use has been made of waste heat from power plants for heating purposes in the United States. Power Plant cooling water, although at elevated temperatures, is still at a relatively low temperature for heating needs. Use of pre-heated water would reduce the energy demands of heating systems, however.

Heating system designs and conveyance of water between power plants and users of the water are obvious considerations. The primary consideration in distance of user from power plant is the cost of the distribution and recirculation system. Typically, temperature losses in pipes of 24-inch diameter or larger with water flowing at 4 fps or greater would be approximately 1° F per 20,000 ft. at a temperature differential of 60° F.

At least one example exists of utilizing power plant cooling water for heating purposes. Residential heating in Reykjavik, Iceland uses hot water discharged from a power plant ten miles distant from the City. It is estimated that heating costs of this system are 40 percent less than if fuel oil were used.

During summer months, power plant discharge could be utilized for air conditioning systems that operate on thermal inputs. Again,

however, economic advantages have not existed to cause significant development. Use of power plant waste heat holds little promise for urban heating and air conditioning unless a total energy system can be integrated into new, large scale development. Use of power plant heated waste may be worthy of consideration in Riverfront New Towns should such a development concept be adopted for further detailed consideration.

SECTION VI

RURAL-URBAN

WATER SUPPLY CONCEPTS

SECTION VI

RURAL-URBAN WATER SUPPLY CONCEPT PLANNING

In this section, nine non-metropolitan and eighteen metropolitan water supply and distribution schemes are formulated. A water supply plan, a growth concept, and possibly supply alternatives comprise each scheme. The four water supply plans consist of three treatment and supply systems developed using traditional sources while the fourth examines the use of various non-traditional supply sources and a dual potable-nonpotable distribution system. Each supply plan is evaluated for sensitivity to the four growth concepts outlined in earlier sections of this report.

The seven county study area is considered in two portions. Douglas and Sarpy Counties in Nebraska and Council Bluffs and vicinity in Iowa are considered the metropolitan area. Each of the growth concepts affects this area. The counties of Washington, Cass, Harrison, Mills, and Pottawattamie excluding Council Bluffs are considered as non-metropolitan. Growth Concepts A, C, and D are the same for the non-metropolitan area with Concept B envisioning development of Blair, Ft. Calhoun, Missouri Valley, Glenwood, and Plattsmouth into satellite cities and establishment of the new towns Florence Precinct, Deer Creek, and East Bellevue in the non-metropolitan area.

Thus the three conventional Supply Plans with two alternatives in Plan I evaluated for two Growth Concepts, B and E (A, C, or D in non-metropolitan area), and Plan IV evaluated for satellite and new cities result in the nine non-metropolitan Schemes summarized below.

Non-Metropolitan Schemes

Water Supply Plan	Growth Concept	Water Supply Alternative
I	B	1
I	E	1
I	B	2
I	E	2
II	B	-
II	E	-
III	B	-
III	E	-
IV	B	-

In the metropolitan area, Supply Plans I thru III are evaluated for each of four Growth Concepts. Two supply alternatives for each Growth Concept in Plan I and evaluation of dual water systems (Plan IV) for Growth Concepts A and C bring the total number of metropolitan schemes to eighteen.

Metropolitan Schemes

Water Supply Plans	Growth Concept	Water Supply Alternative
I	A	1
I	B	1
I	C	1
I	D	1
I	A	2
I	B	2
I	C	2
I	D	2
II	A	-
II	B	-
II	C	-
II	D	-
III	A	-
III	B	-
III	C	-
III	D	-
IV	A	-
IV	C	-

Platte River Plant and the Council Bluffs' Plant discharge filter backwash and softening plant coagulant sludges.

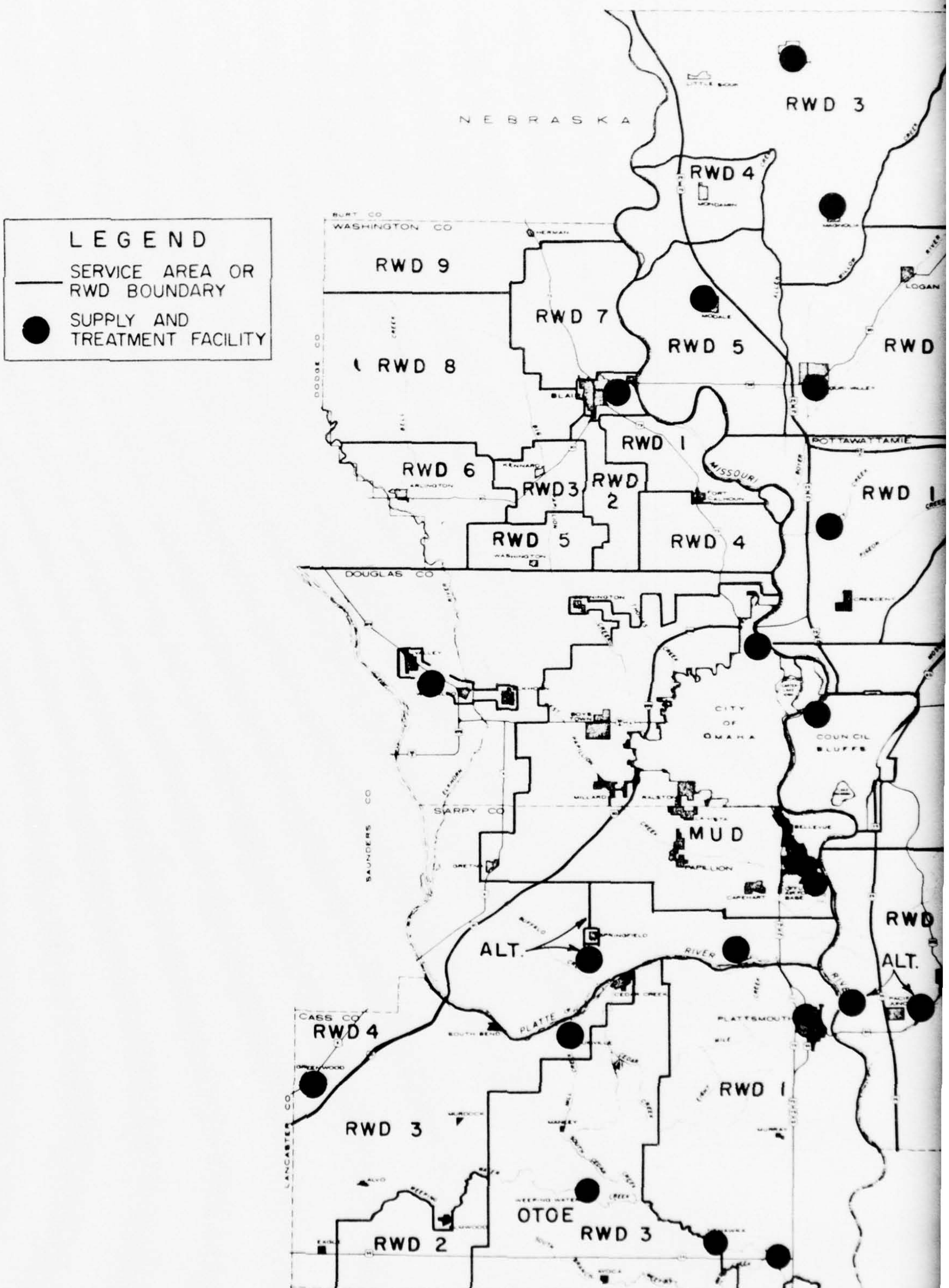
At the Platte River Plant, filter backwash goes to the

Interconnection of rural and metropolitan systems makes total segregation of metropolitan and non-metropolitan schemes impossible. However, separation to the extent possible minimizes duplication of effort in consideration of the identical Growth Concepts A, C, and D in non-metropolitan areas.

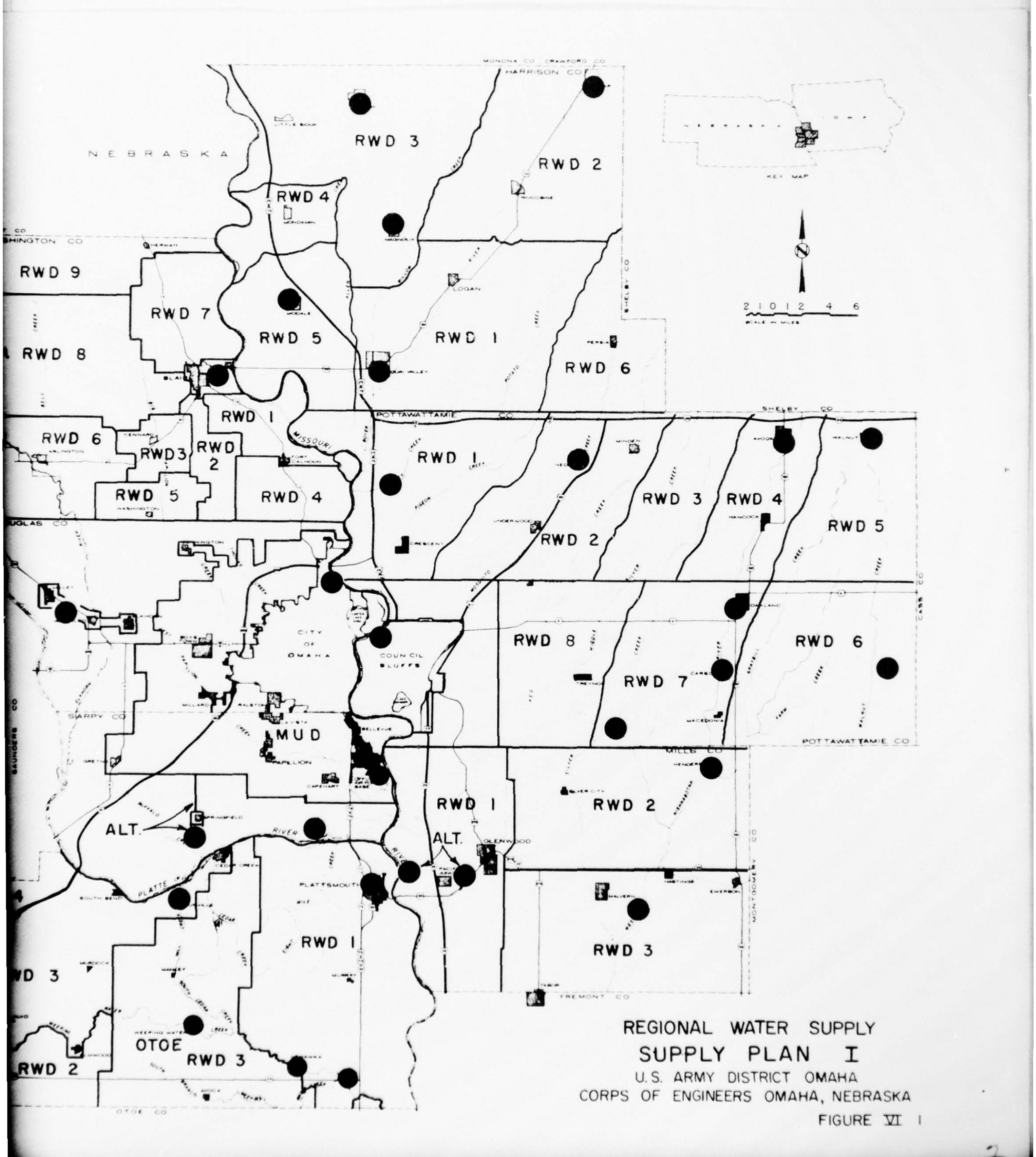
WATER SUPPLY PLANS

Figures VI-1 through VI-3 depict service areas and supply sources for Supply Plans I, II, and III, respectively. Areas of substantial new growth in one or all of the Growth Concepts are considered for dual water systems in Plan IV and are shown in Figure VI-4.

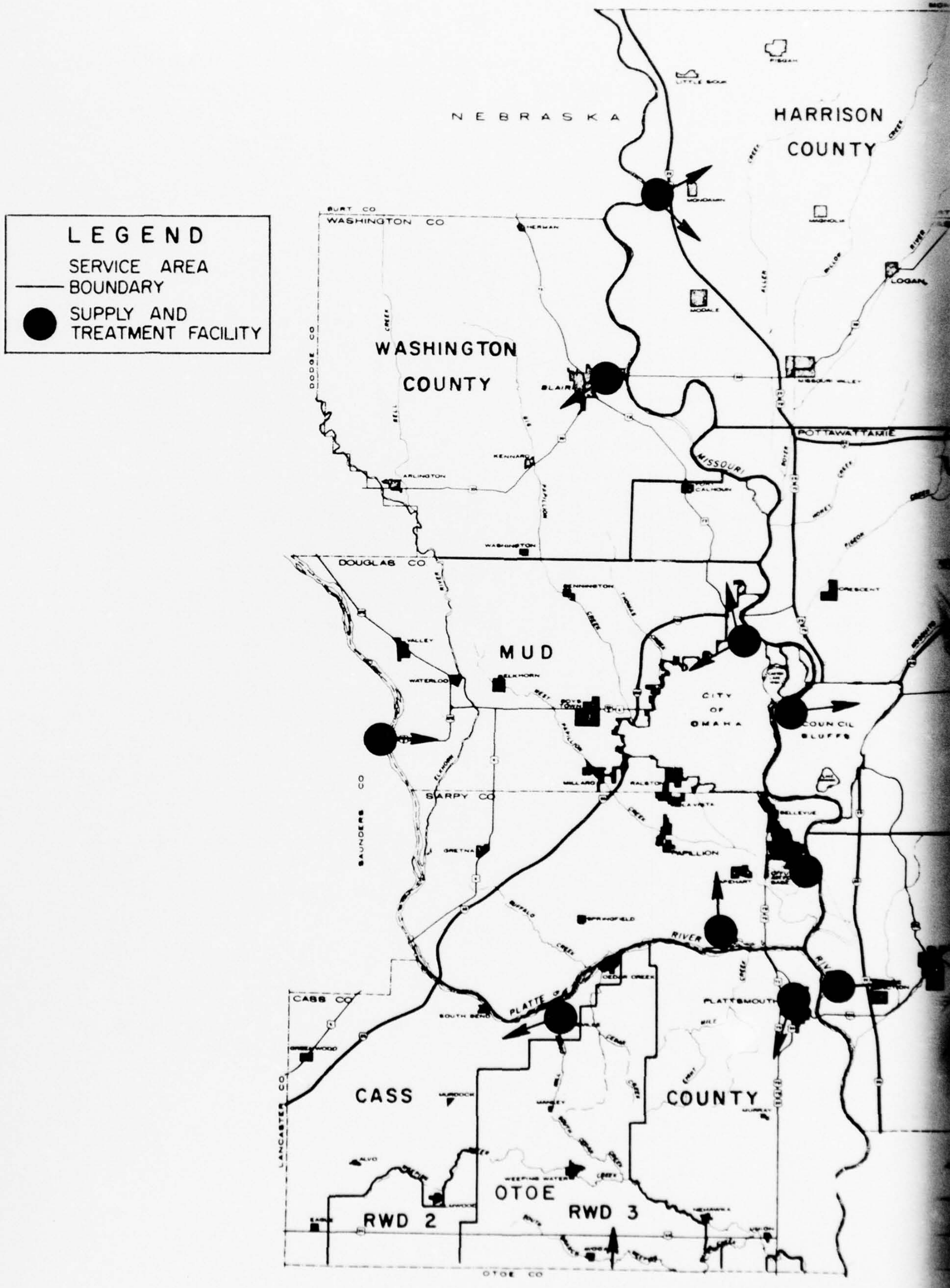
A basic assumption of all Supply Plans is that eventually essentially all area residents will be served by a rural or urban water system and that treatment of all water sources is desirable and beneficial. The existence of county-wide reports for four study area counties, rural water district implementation in a fifth, and eventual service to nearly all residents of Douglas and Sarpy Counties as envisioned in Metropolitan Utilities District Long Range Comprehensive Water System Master Plan is indicative of area resident concern over future water quality and availability and support for centralization and upgrading of supplies. Raw water sources high in hardness or with other constituents in excess of recommended limits and provisions of

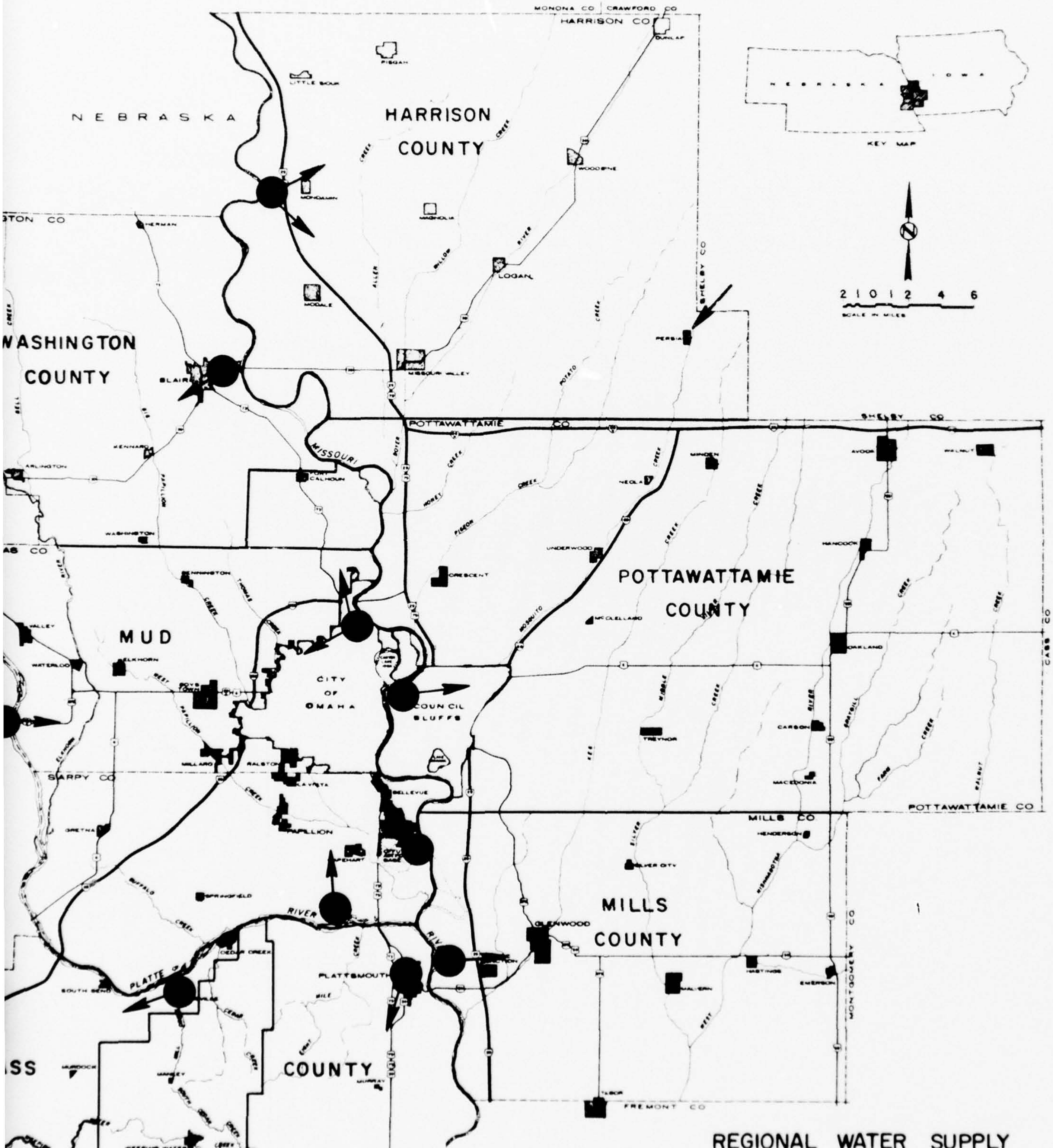


LEGEND
SERVICE AREA OR RWD BOUNDARY
SUPPLY AND TREATMENT FACILITY
NEBRASKA
RWD 3
RWD 4
WASHINGTON CO
RWD 9
RWD 7
RWD 5
RWD 8
RWD 1
RWD 6
RWD3
RWD 2
RWD 5
RWD 4
MISSOURI
POTTAWATTAMIE
RWD 1
DOUGLAS CO
CITY OF OMAHA
COUNCIL BLUFFS
SARPY CO
MUD
ALT.
RIVER
PLATTE
CASS CO
RWD 4
RWD 3
RWD 1
RWD
ALT.
OTOE
RWD 3
RWD 2
OTOE CO
LANCASTER CO
SAUNDERS CO
DODGE CO
LOGAN



REGIONAL WATER SUPPLY
SUPPLY PLAN I
U.S. ARMY DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
FIGURE VI 1

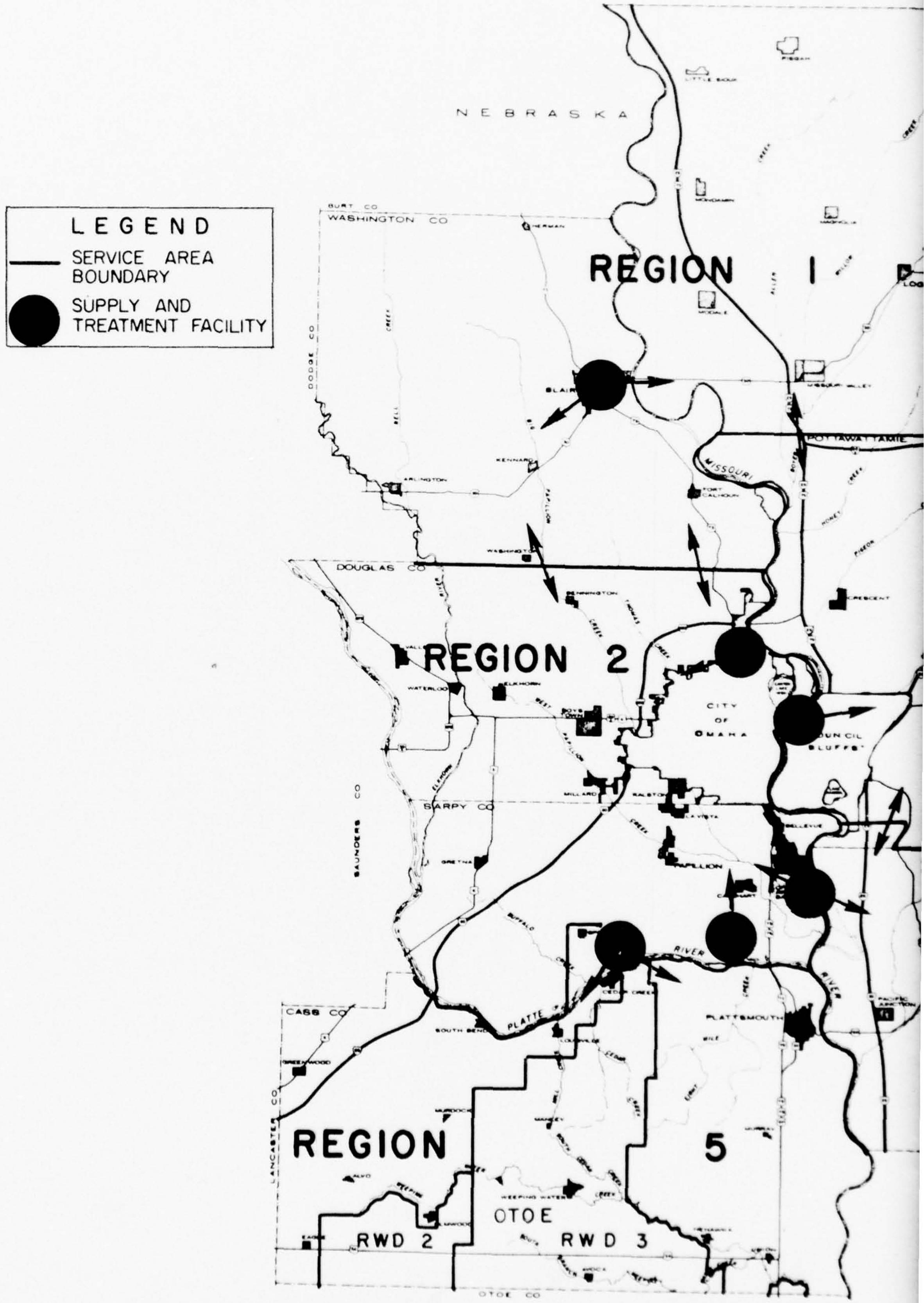

LEGEND
SERVICE AREA BOUNDARY
SUPPLY AND TREATMENT FACILITY
NEBRASKA
HARRISON COUNTY
BURT CO
WASHINGTON CO
WASHINGTON COUNTY
DODGE CO
BLAIR
LOGAN
MISSOURI
POTTAWATTAMIE
DOUGLAS CO
MUD
CITY OF OMAHA
COUNCIL BLUFFS
SARPY CO
SAUNDERS CO
PAPILLION
RIVER
PLATTE
PLATTSMOUTH
CASS CO
CASS
COUNTY
LANCASTER CO
OTOE
RWD 2
RWD 3
OTOE CO

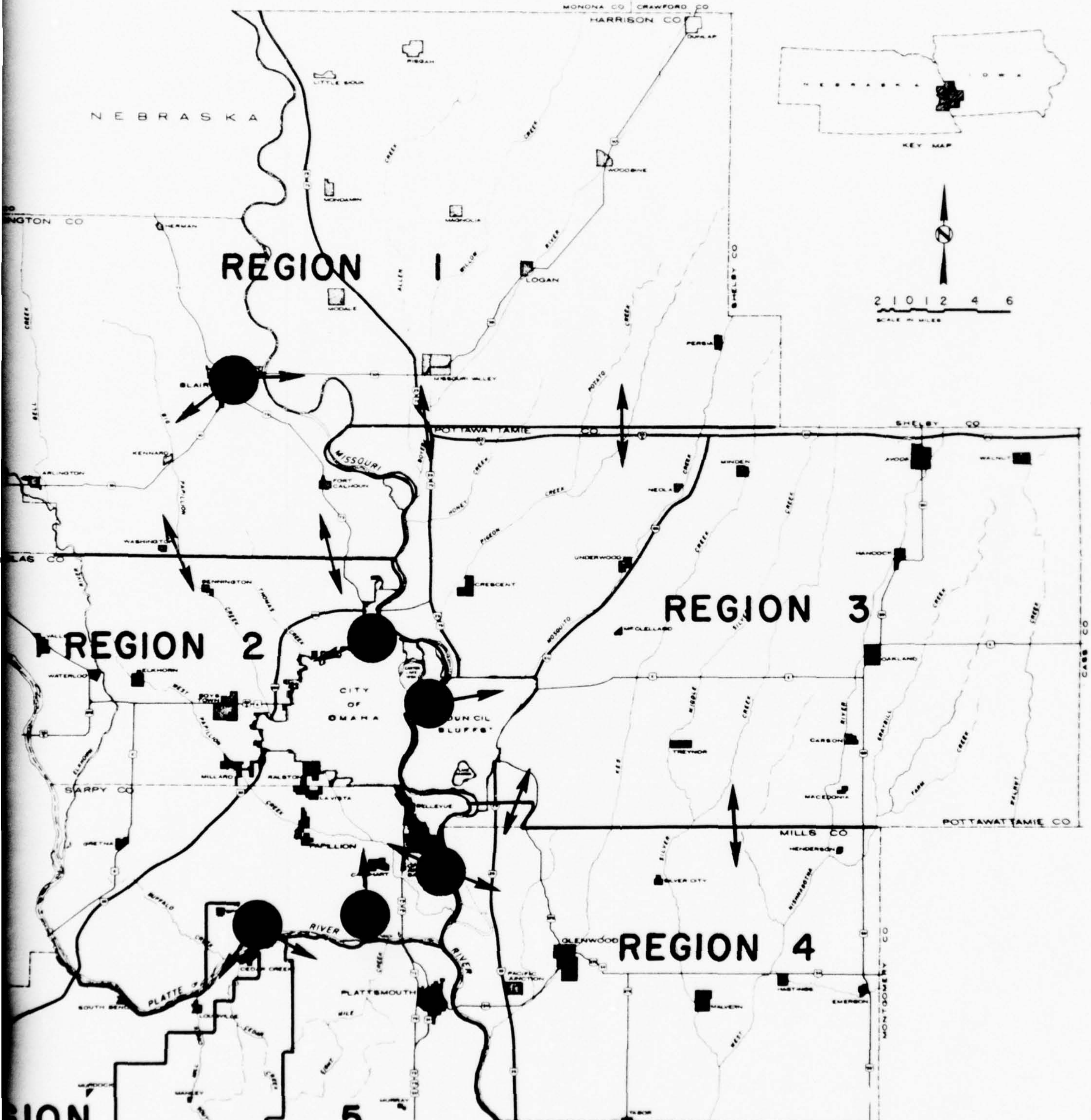


REGIONAL WATER SUPPLY
SUPPLY PLAN II
U.S. ARMY DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE VI 2

2

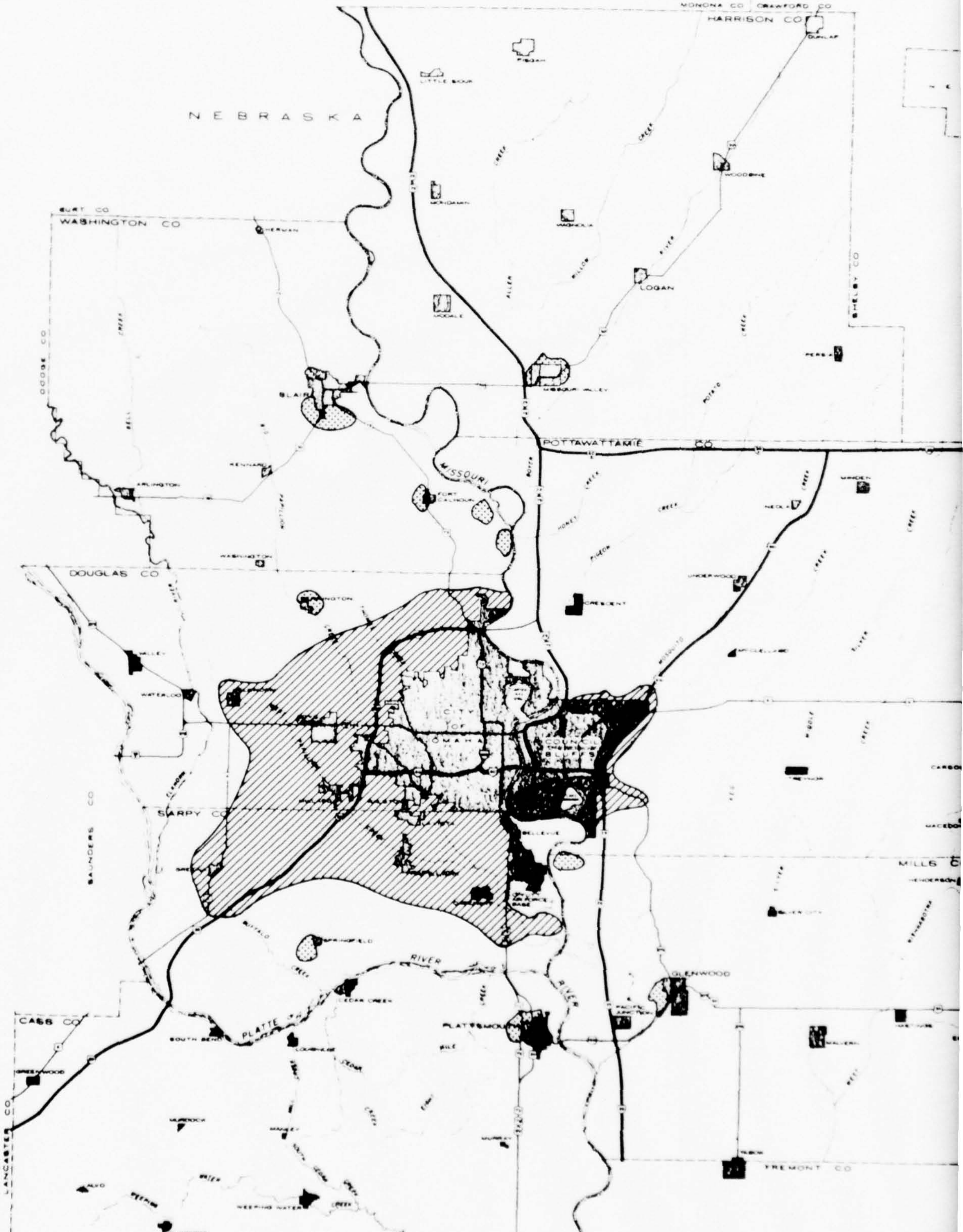

LEGEND
SERVICE AREA BOUNDARY
SUPPLY AND TREATMENT FACILITY
NEBRASKA
BURT CO
WASHINGTON CO
DODGE CO
REGION 1
REGION 2
DOUGLAS CO
SARPY CO
SAUNDERS CO
CITY OF OMAHA
COUNCIL BLUFFS
MISSOURI
POTTAWATTAMIE
CASS CO
LANCASTER CO
PLATTE
RIVER
PLATTSMOUTH
REGION
5
OTOE
RWD 2
RWD 3
OTOE CO



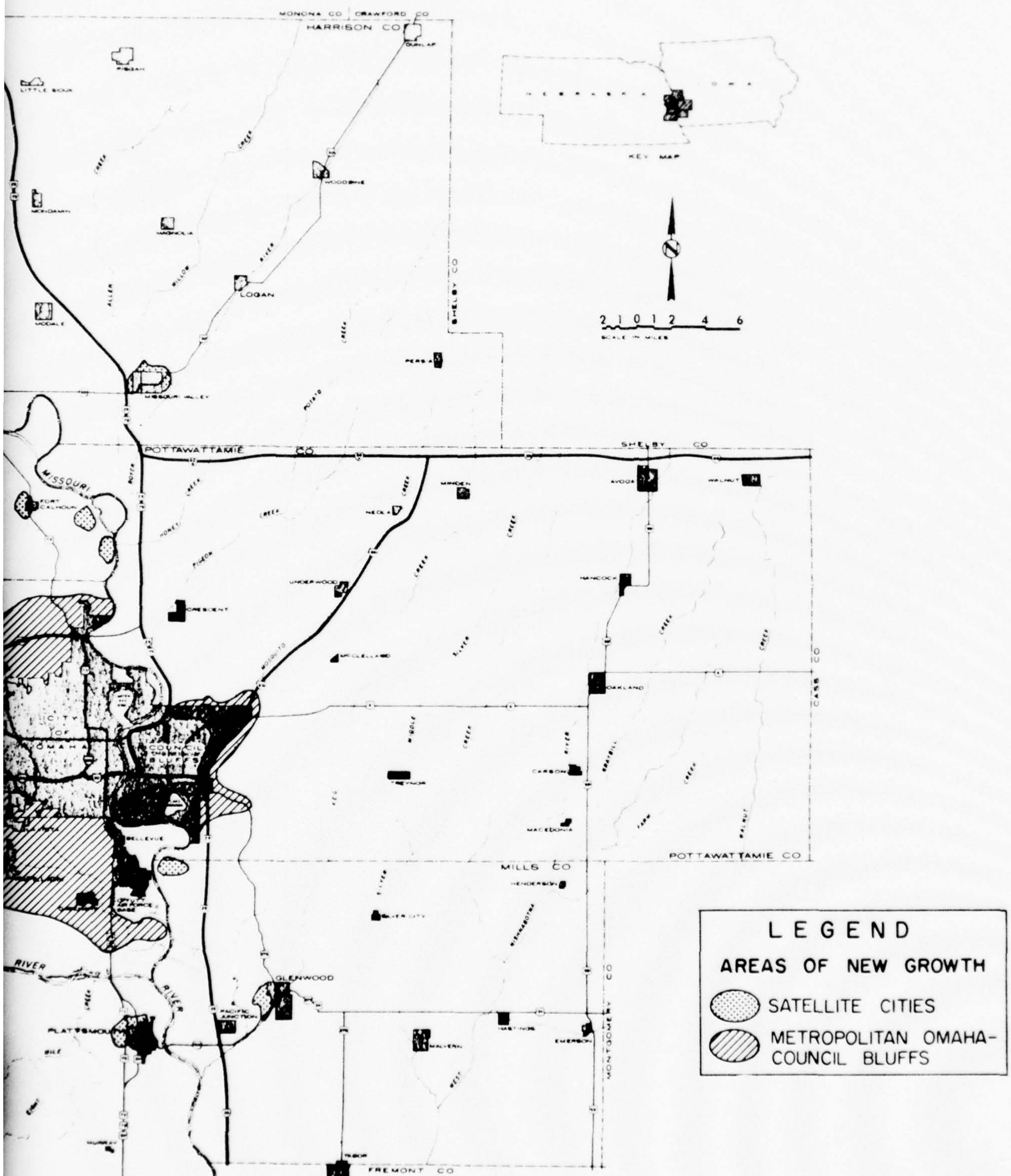
REGIONAL WATER SUPPLY
SUPPLY PLAN III
U.S. ARMY DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE VI 3

2



MONONA CO
CRAWFORD CO
HARRISON CO
NEBRASKA
BURT CO
WASHINGTON CO
DODGE CO
SHELBY CO
LITTLE SIOUX
PISGAH
WOODBINE
MAGNOLIA
LOGAN
MODALE
MISSOURI VALLEY
PERSIA
BLAIR
POTTAWATTAMIE CO
MISSOURI
ARLINGTON
KENNARD
FORT CALHOUN
WASHINGTON
DOUGLAS CO
UNDERWOOD
CRESCENT
VALLEY
WATERLOO
CITY OF OMAHA
COUNCIL BLUFFS
SARPY CO
SAUNDERS CO
BELLEVUE
MILLS C
SPRINGFIELD
RIVER
PLATTE
GLENWOOD
CASS CO
SOUTH BEND
CEDAR CREEK
GREENWOOD
LANCASTER CO
WEEPING WATER
ELMWOOD
EAGLE
FREMONT CO
OTOE CO



REGIONAL WATER SUPPLY

SUPPLY PLAN IV

U.S. ARMY DISTRICT OMAHA

CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE VI 4

2

the 1974 Safe Drinking Water Act make treatment of all potable waters desirable if not a necessity.

Existing systems and system and supply development as recommended in engineering and planning reports form the basis for Supply Plan I. Washington, Harrison, Pottawattamie, and Mills County each have a report proposing rural water districts with boundaries and supply sources as shown in Figure VI-1. RWD 1 in Cass County is in operation with Otoe RWD 3 and Cass RWD 2 in the planning and engineering phase.

In the metropolitan area, Plan I proposes expansion of existing Council Bluffs, Florence, and Platte South treatment plants with new sources developed at a Missouri South site, near Waterloo and possibly at Springfield.

Supply Plan II features increased centralization of supply. The economy and increased reliability and flexibility of larger treatment plants leads to the evaluation of essentially one treatment facility per county in the non-metropolitan counties. The metropolitan area is served by Council Bluffs, Florence, Platte South, and a new Platte West supply and treatment facility.

Complete regionalization with six treatment plants supplying an

interlocked distribution grid is featured in Plan III.

DESIGN CRITERIA

Treatment, storage, and pumping facilities and pipelines are designed and presented to the degree of detail necessary to determine differences in economic, environmental, social, and other impacts due to alternative planning Schemes.

Treatment Facilities

All supply, treatment, and sludge handling components are sized based upon maximum day water demands in the area served. Plants of less than 2 mgd capacity are designed to meet maximum day requirements in less than 24 hour operation. The burden upon plant personnel (often one man in very small plants) and lack of reliability (single units for some operations) make continuous operation both impractical and undesirable in small treatment facilities. Plants larger than 2 mgd are sized to provide an adequate maximum day supply in 24 hours of operation.

Treatment plants for surface water source are to have an intake structure at the supply source with screening and low lift pumps. Treatment will consist of presedimentation with polyeletrolyte treatment and/or prechlorination, sedimentation and softening using lime, soda ash, and alum, and rapid sand filtration. Well fields for small treatment facilities have wells sized from available geologic information including

size of existing wells in the area. A sufficient number of wells is developed to supply maximum plant capacity with a minimum of one well out of service. Ground water treatment will consist of oxidation of iron and manganese, lime softening, and rapid sand filtration.

All waste sludges from treatment plants of less than 2 mgd capacity will be lagooned. Softening and iron and manganese sludges from larger treatment facilities will be mechanically dewatered and trucked to landfill or land reclamation sites. Presedimentation sludge from plants having a surface water source is lagooned. Filter backwash is lagooned or recycled to the treatment process. All dewatering waste streams and lagoon supernatant are returned to the start of the water treatment process.

Lagooning is a proven and economical method of sludge disposal. However land requirements make it economically and ecologically desirable to use alternative disposal means at larger facilities. Changes in land use alter lagooning plans of the MUD Master Plan. Area studies such as that of the Council Bluffs Plant find mechanical dewatering and landfilling as preferable to such disposal methods as dumping

in a sanitary sewer system or recalcination of lime sludge. Lagooning is retained in larger facilities as the process of preference for disposal of presedimentation sludges because of the lack of experience or literature information, especially in this area, in the handling of these sludges. Return of all supernatant and dewatering waste streams to the water treatment process insures compliance with as of yet unpublished final Environmental Protection Agency discharge restrictions.

Booster Pumping Stations

Primary high service pumping facilities are included as a portion of the treatment facility. Rural and major metropolitan booster stations are sized to pump 1.25 times maximum day service area water demand with a pressure increase of up to 80 psi, normally from about 40 psi to 100 psi. Booster pumping stations in rural communities are included in the per capita distribution system cost in the next chapter of this report.

Storage Facilities

Rural water district and rural community storage facilities are sized to store an average days water requirement for the area of service. Type of storage (elevated, standpipe, or ground level steel or concrete) is chosen based upon type of existing storage, size required, and topography.

Storage requirements to provide first class fire protection determine storage facility capacity for cities with a population exceeding 10,000. Peak shaving as outlined in MUD's Water System Master Plan is used as the basis for storage in this system.

Pipelines

Supply of design (2020) maximum day demand at a velocity of less than 3 fps is the design criterion for rural transmission and major distribution pipelines. Minor rural distribution mains, those less than 4-inch diameter, and service lines are not designed or laid out specifically. From existing reports and designs, four miles of minor mains and service lines for each mile of major distribution main was determined as a ratio to be used for costing purposes.

All metropolitan area pipelines 24-inches in diameter and greater are shown in Figures in this chapter. Piping networks and sizes are those designed in MUD and Council Bluffs Master Plans adjusted based upon supply and growth variations of the several schemes. Pipelines of less than 24-inch size are shown only when they serve as a transmission main to some area or city.

Expansion and improvement of rural community piping networks and distribution pipelines of less than 24-inch diameter in the metropolitan

area are not addressed specifically in this report. For purposes of economic analysis, a per capita cost was derived from engineering reports to cover minor distribution mains, service lines and meters in metropolitan areas and all in-city pipelines, meters, and booster pumping stations in rural communities.

Staging

Construction and expansion of water treatment and distribution facilities is assumed to be in stages in most instances. Rural water districts not currently in final planning or implementation stages are assumed to be constructed and operational in 1985. In all instances, initial installation of pipelines capable of carrying 2020 design loads to rural areas is more economical than staging and paralleling pipelines because of the long distances and relatively small demand increases involved. Rural booster pumping stations and storage facilities are staged where future demands increase significantly over initial requirements.

Non-metropolitan treatment plants are generally staged in 3 or 4 steps. An initial 1975 construction or expansion is sized to supply 1984 needs. Expansions and new plant construction in 1985 coincide with implementation of rural water districts and are designed to meet 1995 demands. Additional expansions in 1995 and 2007 are based upon 2007 and 2020 loads respectively. Treatment plants serving only

rural areas and small communities often have no expansions since demand increase from 1985 to 2020 is minor or nonexistent.

All facilities, treatment, storage, pumping, and pipelines are staged in the metropolitan area. Treatment, storage, and pumping facilities are expanded at from 5 to 15 year intervals depending upon demand growth in the area of service. Pipelines are extended into areas of new growth and phased in built-up areas using 1995 and 2020 population boundaries of the various growth concepts and staging outlines of the MUD and Council Bluffs Master Plans as guidelines.

Per capita costs due to system expansion generated for the economic analysis are assigned to 1985 and 2007 as midpoints of the 1975 to 1995 and 1995 to 2020 design periods.

General

Rural water district system design is conservative since service of entire rural population and livestock in current (1973) populations is assumed. In actuality, all rural residences will probably not be served and, while the number of livestock is expected to increase, existing private wells or impoundments will continue to supply significant quantities of water for livestock. Industrial development outside of the rural communities is not considered in system design

since it is impractical to design a rural system to serve prospective industrial users knowing neither location nor water requirements. It is expected that an industry, most likely a large feedlot operation, will carefully examine water quality and availability before selecting a rural location and will develop its own supply.

Dual Systems

A dual water system utilizes two sources of supply, i. e. potable and nonpotable sources. Dual systems are evaluated on the basis that both supplies must be of a quality that is bacteriologically safe. This precludes the possibility of contamination resulting from cross-connections and insures a high degree of public safety.

United States Public Health Standards for Drinking Water are the minimum quality criteria for a potable system. This system must be capable of furnishing water for the following home uses: drinking, cooking, dishwashing, cleaning, bathing, laundering and for operation of garbage disposal units. Provisions for limited industrial and commercial use requiring high quality process water will also be included.

The nonpotable supply will be used for waste transport (toilet flushing), lawn and garden irrigation, street flushing, fire protection,

and for commercial and industrial uses such as cooling and air conditioning where a high degree of quality is not required. The nonpotable supply must be disinfected to insure biological safety and should be free of chemical constituents which are acutely toxic to plants and/or animals. In addition, the supply should not exhibit excessive staining, scale forming or corrosive tendencies at normal temperatures. Odor and color of nonpotable water should not be objectionable.

Surface water is assumed to require a minimum level of treatment consisting of sedimentation and chlorination in order to maintain a uniform level of quality and provide biological safety. Chlorination is assumed to be the minimum degree of treatment necessary for ground water supplies. Stormwater runoff treated to level 2 and wastewater treated to level 3 are assumed to be of adequate quality for nonpotable use.

Level 3, wastewater treatment is the Corps of Engineers' interpretation of Public Law 92-500 requirements for zero discharge. A summary of the effluent standards associated with the 3 levels of treatment outlined in the Regional Wastewater Management Study Phase are presented in Table VI-1.

TABLE VI-1
WASTEWATER EFFLUENT STANDARDS

Treatment Goal	Level	BOD	SS	DO	NH_3-N	Org N	NO_2 & NO_3 as N	T. Phos.	Fecal Coliform	pH
WASTEWATER TREATMENT										
Secondary	1	30	30	N.A.	20	20	N.A.	10	200/100ml	6-9
BBT-Water Quality	2	*	*	*	*	*	*	*	*	*
Zero Discharge	3	5	5	N.A.	0.5	5	4	0.1	200/100ml	6-9

* Limit determined by effect on stream of oxygen-demanding materials, nutrients, toxicity and fecal coliforms, with nitrification included in all cases.

N.A. - Not Applicable

Level 1 (secondary treatment) and Level 2 (BPT-Water Quality) are considered unsuitable for nonpotable use, principally for aesthetic reasons, and would require additional treatment to obtain a quality equivalent to that of Level 3.

Three effluent standards are established in the wastewater management phase for urban stormwater runoff discharges and are shown in Table VI-2.

TABLE VI-2

SUMMARY OF EFFLUENT STANDARDS FOR STORMWATER TREATMENT

Stormwater Treatment

Level 1	Screening, sedimentation, disinfection. Estimated 40% removal BOD; 70% removal SS; to 200/100 ml fecal coliforms.
Level 2	Treatment necessary to meet water quality standards in receiving streams, except that higher treatment may be required for some Papio tributaries to protect quality of impoundments.
Level 3	Treatment required for re-use as public or industrial water supply source.

Level 1 treatment consists of screening, sedimenation, and disinfection. This degree of treatment is considered inadequate in terms of maintaining a uniform quality level suitable for nonpotable use. Level 2 is established to provide treatment necessary to satisfy water quality standards in receiving streams. Level 2 stormwater and Level 3 wastewater treatment are used to determine the incremental costs associated with alternative plans developed in the wastewater management phase. Level 2 stormwater treatment includes microscreening in addition to Level 1 treatment. This degree of treatment is considered to be commensurate with Level 3 wastewater treatment. Level 3 stormwater treatment is established to provide an effluent quality suitable for potential use as a potable supply. This

level of quality exceeds the requirements of nonpotable system.

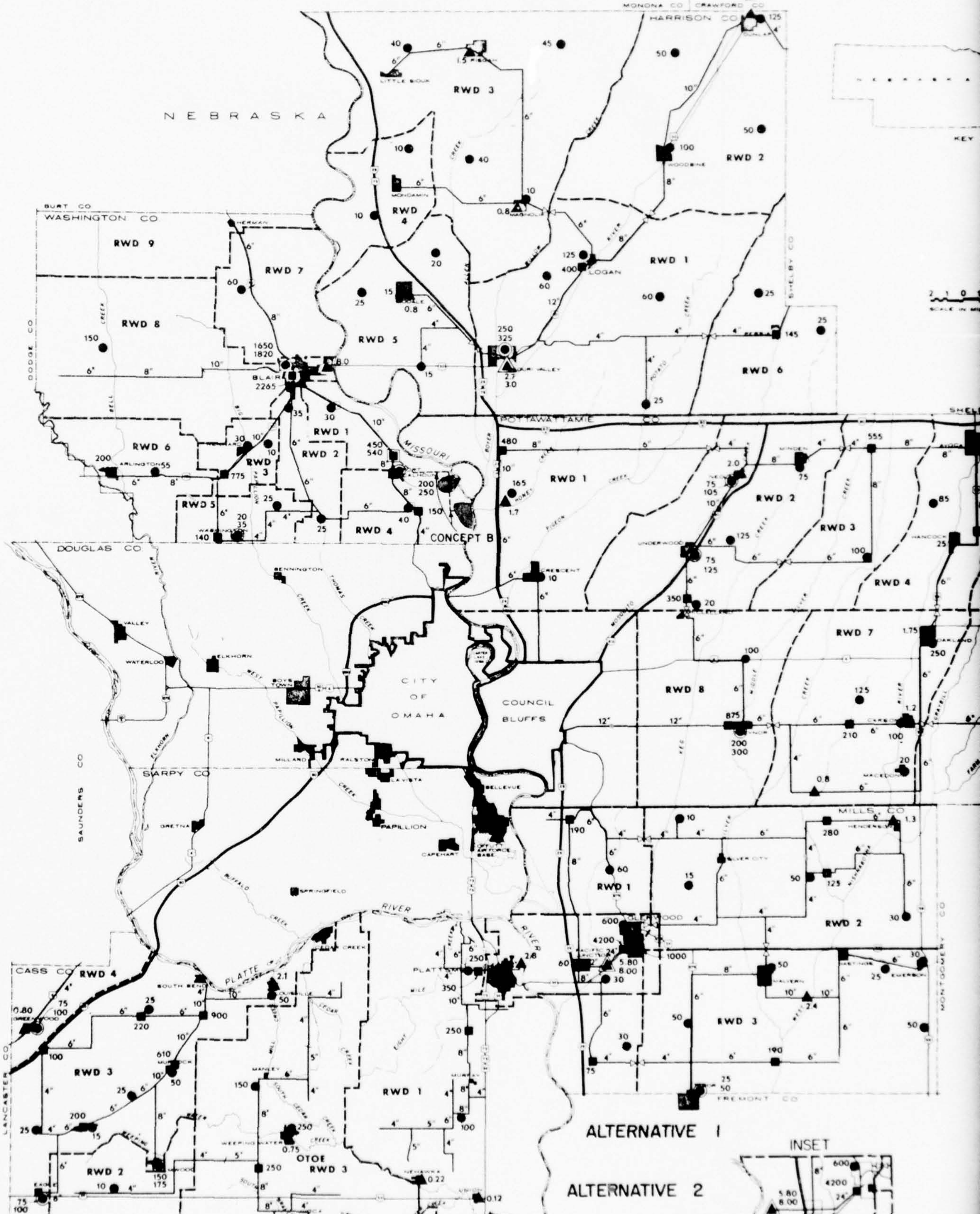
For dual system cost analysis, Level 3 wasterwater, Level 2 stormwater, disinfected groundwater, and treated surface water are regarded as potential sources of supply for a nonpotable system. Each source is assumed to be capable of providing a common level of water quality. Lesser degrees of treatment associated with the four potential supply sources would require additional treatment equivalent to the minimum acceptable level established for the respective sources.

WATER SUPPLY SCHEMES

Plan I.

Omaha Metropolitan Utilities District and Council Bluffs long range plans; Washington, Harrison, Pottawattamie, and Mills County comprehensive water supply reports; water supply and distribution reports of several cities; and rural water districts in planning or implementation stages in Cass County are integrated in this supply concept. Thus supply and distribution systems are generally by county except for the MUD and Council Bluffs systems.

Non-metropolitan Area. A detailed layout of Plan 1 for the nonmetropolitan areas is shown in Figure VI-5.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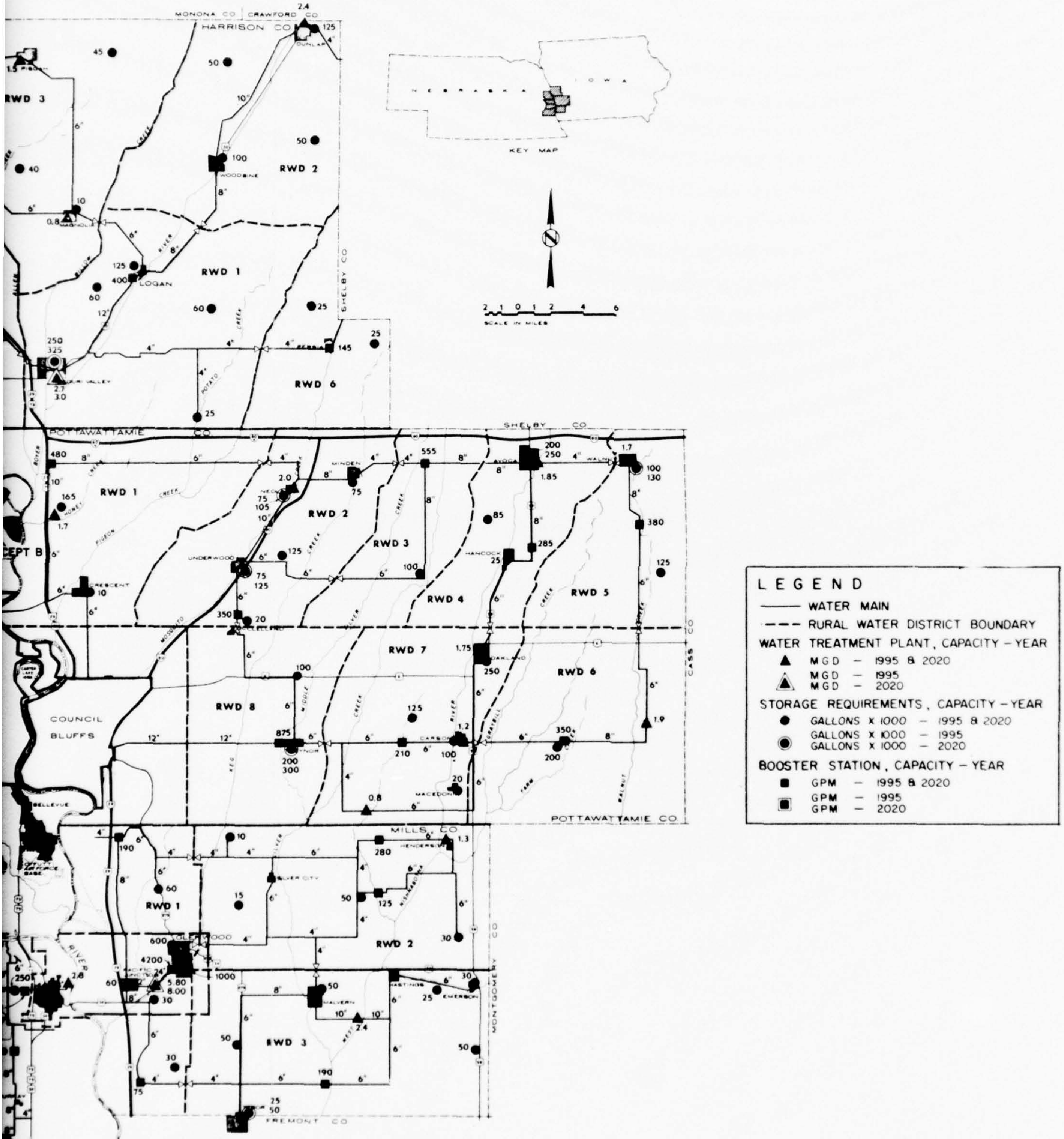
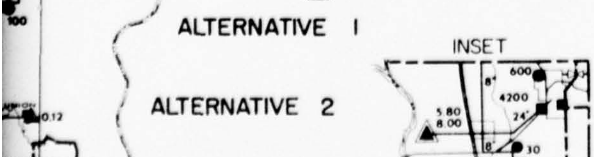
BURT CO
WASHINGTON CO
DODGE CO
DOUGLAS CO
SARPY CO
SAUNDERS CO
CASS CO
LANCASTER CO
OTOE CO
POTTAWATTAMIE CO
SHELBY CO
MILLS CO
FREMONT CO
MONTGOMERY CO
RWD 1
RWD 2
RWD 3
RWD 4
RWD 5
RWD 6
RWD 7
RWD 8
RWD 9
BLAIR
LOGAN
WOODBINE
MISSOURI
CONCEPT B
CITY OF OMAHA
COUNCIL BLUFFS
PLATTE RIVER
ALTERNATIVE 1
ALTERNATIVE 2
INSET





REGIONAL WATER SUPPLY

PLAN I NON-METROPOLITAN

U.S. ARMY DISTRICT OMAHA

CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE VI - 5

2

Washington County. A 1968 report entitled Washington County Comprehensive Water and Sewer Study divides the county into nine rural water districts. Eight of the districts, including all rural communities, are inter-connected and served from a single facility at Blair, treating Missouri River water. An area of northern Washington County designated RWD IX would not be served by the system developed in the county study, apparently due to a high capital cost per connection. The distribution network for Washington County essentially as presented in the county report is sized for water demands calculated in this report and is shown in Figure VI-5. The treatment plant at Blair is to treat surface water and is considered as a new facility with initial construction in 1975 based upon recommendations of a report on water supply and treatment for the City of Blair. Capacity and average daily treatment of this plant area are respectively 8.00 mgd and 4.30 mgd for Growth Concept E, and 19.25 mgd and 10.95 mgd for Growth Concept B.

Harrison County. A 1967 county-wide comprehensive water and sewer study recommends serving Harrison County from six rural water districts. Five of the districts are interconnected with well field supplies located in four of the district. Harrison County RWD

6 serving the southeastern part of the county including the Town of Persia is to be supplied by a rural water district in Shelby County. All communities in the county are to be included in the rural districts. The distribution system as presented in the Harrison County report with some modifications is shown in Figure VI-5. Well fields of the capacities required at the locations indicated in the county report will probably require numerous small yield wells with questionable reliability under extended maximum production conditions. Investigation of well field sites and capacities would be required prior to implementation of this supply concept.

Harrison County treatment plant location and 2020 capacity and average treatment are summarized in Table VI-3.

TABLE VI-3

PLAN I TREATMENT PLANT-HARRISON CO.

Location	Source	Capacity (mgd)	Av. Treatment(mgd)
Modale	Ground	0.82	0.22
Pisgah	Ground	1.05	0.37
Magnolia	Ground	0.75	0.24
Dunlap	Ground	2.00	0.79
Missouri Valley	Ground	2.60[1]	1.32[1]
		4.80[2]	2.48[2]

[1] Growth Concepts A, C, and D. [2] Growth Concept B

Pottawattamie County. A 1968 comprehensive county-wide water and sewer study divides Pottawattamie County, exclusive of the Council Bluffs area, into eight rural water districts. One of the rural water districts and the Town of Crescent are to be served from the Council Bluffs system with eight well fields in six of the districts serving the remaining areas. As in Harrison County, ability of the proposed well fields to supply the counties rural water district needs should be carefully explored before implementation of this plan.

Supply and distribution systems for the rural water districts as presented in the county report with minor modifications are shown in Figure VI-5 exclusive of the Council Bluffs system. Table VI-4 summarizes Pottawattamie County treatment plants supplying non-metropolitan areas. East Bellevue, a Mills County new town in Growth Concept B, will be served from Council Bluffs.

TABLE VI-4

PLAN I TREATMENT PLANTS - POTTAWATTAMIE CO.

Location	Source	Capacity(mgd)	Av. Treatment(mgd)
Honey Creek	Ground	1.65	0.68
Neola	Ground	2.60	1.13
Avoca	Ground	2.60	1.13
Walnut	Ground	1.70	0.72
RWD6	Ground	1.90	0.78
Oakland	Ground	1.50	0.49
Carson	Ground	0.70	0.28
5. RWD7	Ground	0.70	0.24
Council Bluffs	Surface	2.75 to 31.0[1]	0.82[1]
	Surface	2.80[2]	2.32[2]

[1]Growth Concepts A, C, and D

[2]Growth Concept B

Mills County. A comprehensive water and sewer plan prepared in 1970 proposed three self-supplied, interconnected rural water districts serving all of Mills County. The county study locates a well field in each district to serve the district. Aquifers along the Nishnabotna River in easterm Mills county should be adequate to supply needs of the two eastern water districts.

A 1971 report on Glenwood's water system predicted a year 2000 population of 6300 with an additional 800 in the state school at Glenwood. An expansion program was proposed to serve this population growth which included a 5.5 mgd well field and treatment plant near Pacific

Junction. The population and water usage predictions of the city report are used even though they greatly exceed predictions of the county report. The proposed 5.5 mgd treatment plant is found to be adequate for the entire Mills County RWD #1 for 1995 with expansion to 8.0 mgd required by 2020. Construction of a new river intake and treatment plant is evaluated as an alternative to expansion of the existing well water supply and treatment for this district.

Water supply and distribution systems for Mills County Plan I are shown in Figure VI-5. Treatment plant location, source, and 2020 capacities and average treatment are summarized for Mills County in Table VI-5.

TABLE VI-5

PLAN I TREATMENT PLANTS - MILLS COUNTY

Location	Source	Capacity(mgd)	Av. Treatment(mgd)
Henderson	Ground	1.00	0.39
near Malvern	Ground	2.10	0.90
Pacific Junction	Ground	7.72[1,3]	4.70[1,3]
	Ground	8.22[2,3]	4.94[2,3]
	Surface	7.75[1,4]	4.70[1,4]
	Surface	8.25[2,4]	4.94[2,4]

[1]Growth Concept A, C, and D

[2]Growth Concept B

[3]Supply Alternative 1

[4]Supply Alternative 2

Cass County has one rural water district currently under construction, one RWD with a preliminary design and one RWD in the planning stage. Cass County RWD 1 is under construction and will serve approximately the eastern one-third of the county (see Figure VI-5) with Plattsmouth's well field and treatment plant supplying the water. A preliminary RWD design serves central Cass County from Otoe County RWD 3 which is supplied from wells in the Nemaha Valley in extreme southern Otoe County. A small district designated Cass County RWD 2 is in the planning stage and would buy its water from Otoe County RWD 3. These rural water districts will remain the same for all supply concepts, since they will probably be operational

within the next few years. The remainder of the county has been divided along I-80 to form two districts - RWD 3 supplied from Louisville and RWD 4 supplied from Greenwood. It is quite possible that the RWD 4 area may be served from a district outside the service area but a small self-supplied district will be assumed for this concept. The Towns of Weeping Water, Nehawka, and Union which are within the boundaries of the two RWD's already developed but not served by them are assumed to be self-served by new supply and treatment facilities in this Plan.

Continued use of Plattsmouth's existing plant treating ground water versus construction of a new facility with a Missouri River intake is also compared.

Cass County treatment and supply facilities are shown in Figure VI-5 and treatment plants are summarized in Table VI-6.

TABLE VI-6

PLAN I TREATMENT PLANTS - CASS COUNTY

Location	Source	Capacity(mgd)	Av. Treatment(mgd)
Louisville	Ground	2.10	.79
Greenwood	Ground	0.80	0.21
Weeping Water	Ground	0.75	0.25
Union	Ground	0.12	0.03
Nehawka	Ground	0.20	0.11
Plattsmouth	Ground	3.60[1,3]	1.29[1,3]
	Ground	8.25[2,3]	3.79[2,3]
	Surface	3.60[1,4]	1.29[1,4]
	Surface	8.25[2,4]	3.79[2,4]

[1]Growth Concepts A, C, and D

[2]Growth Concept B

[3]Supply Alternative 1

[4]Supply Alternative 2

Metropolitan Area. Plan I for the metropolitan area is shown for Growth Concepts A, B, C, and D in Figures VI-8 through VI-11, respectively. Treatment facilities for Plan I are summarized in Table VI-7.

TABLE VI-7

PLAN I TREATMENT PLANTS - METRO-
POLITAN AREA-2020

Location	Growth Concept	Capacity(mgd)	Av. Treatment(mgd)
Florence	A	235	109.66
	B	255	118.53
	C	260	121.98
	D	235	108.88
Platte River South	A	80	34.01
	B	60	23,12
	C	75	32.65
	D	75	32.46
Missouri River South	A	170[1] 170[2]	72.45[1] 71.50[2]
	B	100[1] 100[2]	51.59[1] 47.15[2]
	C	135[1] 130[2]	58.93[1] 57.98[2]
	D	170[1] 165[2]	71.88[1] 70.93[2]
Council Bluffs	A	30.0	16.15[3]
	B	28.0	13.88[3]
	C	27.5	15.46[3]
	D	31.0	16.76[3]
Springfield	E	2.0[2]	.95[2]
	B	8.5[2]	4.44[2]
Waterloo	E	2.6	1.28
	B	8.4	4.15

[1]Supply alternative 1

[2]Supply alternative 2

[3]Portion supplied to Metropolitan Council Bluffs

Douglas and Sarpy Counties. The principal water utility in these counties, the Omaha MUD, has developed a Long Range Comprehensive Water System Master Plan which envisions serving a major portion of the two county area by 2020. The Master Plan foresees service to Papillion, Offutt, and the unserved portion of Bellevue by 1985 and other communities and rural areas between 1995 and 2020.

to be developed under this plan is a well field along the Platte River, south of Valley. As pointed out in the MUD report and further substantiated by preliminary results of the Platte River Level "B" Study, capacity of this source is limited by the diminished recharge available from a Platte River flow depleted by increasing upstream irrigation. Therefore, the alternative Missouri River source proposed in the MUD report is used in this concept with a Platte River Valley site used as a common source for Valley, Waterloo, and Elkhorn.

"Plan C" of the MUD report is developed to serve metropolitan Omaha. The MUD system is extended to serve Gretna and Bennington with the alternatives of MUD (Alternative 1), or self-service (Alternative 2) evaluated for Springfield. Rural areas are not served by a rural water district since most of the comparatively small rural population has a large quantity of good quality ground water readily available or could be served by minor extensions of the MUD system prior to full service by MUD.

Council Bluffs has a Water Distribution System Master Plan prepared in 1972 which recommends expansion of the existing plant treating Missouri River water as needs increase. Distribution system expansions outlined to meet 1995 needs as projected in the

Council Bluffs report are adequate to serve Growth Concept populations to 2020 because of the lower growth rate and lesser sprawl of these projections. Major new feeder mains of the Council Bluffs system are approximately the same as presented in the Council Bluffs report with changes in staging to meet the reduced growth rate.

Plan II

Water supply and treatment facilities are centralized along the Missouri and Platte Rivers where an adequate supply of water is assured in Water Supply Plan II. Treatment plants decrease in number and increase in size while booster pumping stations and pipelines generally increase in size because of the enlarged service areas of the treatment plants.

Non-metropolitan Area. Features of Supply Plan II are shown in Figure VI-6.

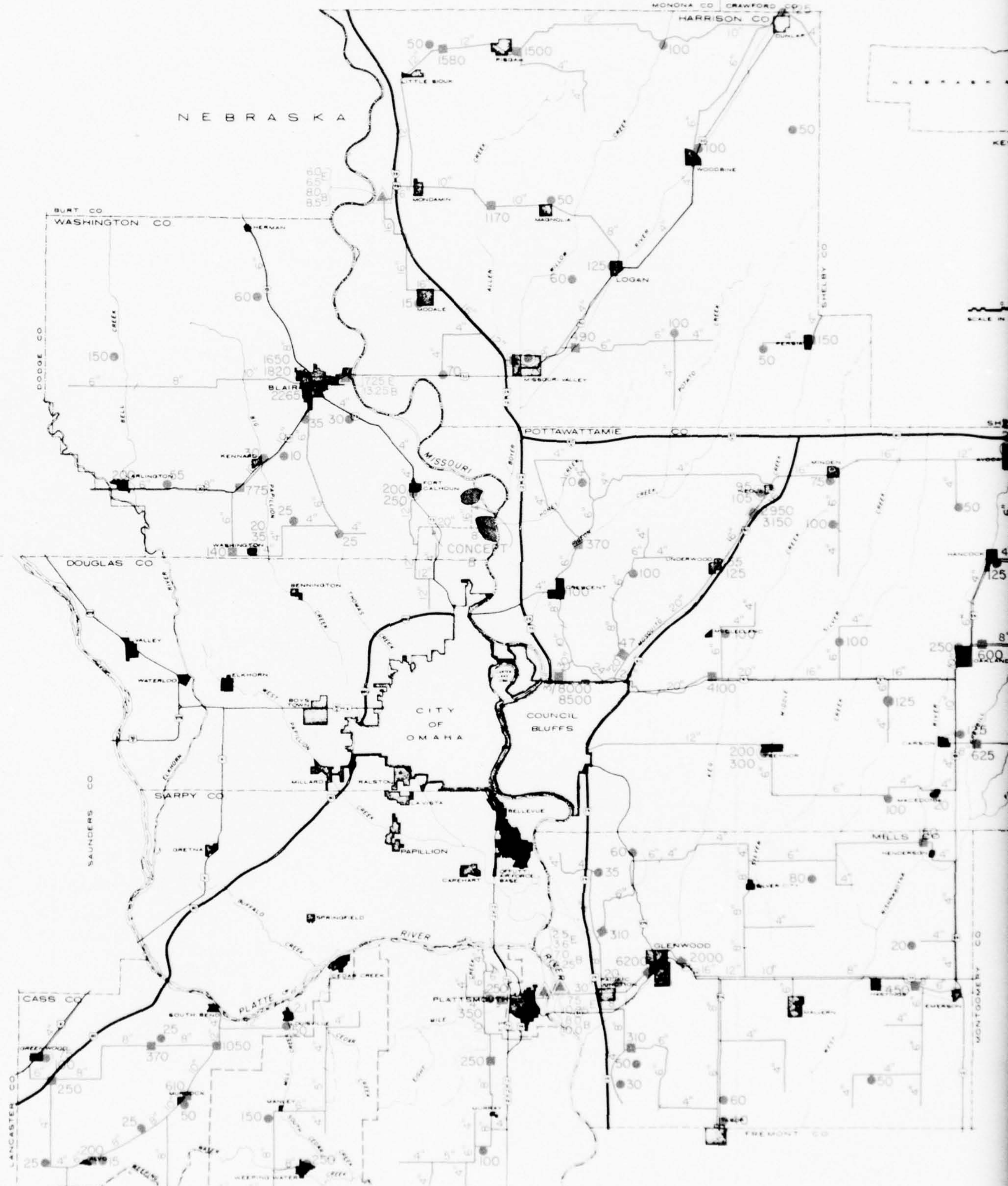
Washington County. The supply and distribution network remains the same for Washington County in Plan II as in Plan I, with the exception of the southeastern portion of the county. A 1974 report prepared under the auspices of the Papio Natural Resources District evaluated service to various areas of Washington County from the MUD system. MUD service of a portion of southeastern Washington County conforming roughly to RWD4 of Plan I including Ft. Calhoun and the

unincorporated Village of Nashville was recommended. Water would be purchased from MUD with MUD's Rainwood Road pumping station providing booster pumping and Ft. Calhoun's facilities providing storage. The Papio NRD system is incorporated in Plan II including expansion to serve the new towns of Deer Creek and Florence Precinct in Growth Concept B.

Capacity of the Blair treatment facility is 7.25 mgd and 13.25 mgd and average daily treatment 3.91 mgd and 7.19 mgd for Growth Concept E and B respectively in 2020.

Harrison County. The five Harrison County rural water districts served from sources within the districts in Plan 1 are combined into a single district served from a single source along the Missouri River in Plan II. The sixth district remains served from a Shelby County rural water district. Alternative supply sources of a river intake with treatment plant and a well field with treatment plant are evaluated. The treatment facility would have a 2020 capacity and average daily treatment of 6.50 mgd and 3.32 mgd in Growth Concept E and 8.5 mgd and 4.47 mgd in Growth Concept B. The distribution system for Plan II is shown in Figure VI-6.

Pottawattamie County. Water will be supplied to all of Pottawattamie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SAUNDERS CO
MILLS CO
CASS CO
LANCASTER CO
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COUNCIL BLUFFS
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PLATTE RIVER
BLAIR
LOGAN
WOODBINE
MISSOURI VALLEY
MONDAMIN
MAGNOLIA
MODALE
FORT CALHOUN
KENNARD
ARLINGTON
WASHINGTON
BENNINGTON
VALLEY
WATERLOO
ELKHORN
BOYS TOWN
MILLARD
RALSTON
LA VISTA
PAPILLION
BELLEVUE
GRETNA
SPRINGFIELD
CAPEHART
CRESCENT
UNDERWOOD
MINDEN
HANCOCK
OAKLAND
CARSON
MACEDONIA
HENDERSON
GLENWOOD
EMERSON
MALVERN
PLATTSMOUTH
SOUTH BEND
GREENWOOD
MURDOCK
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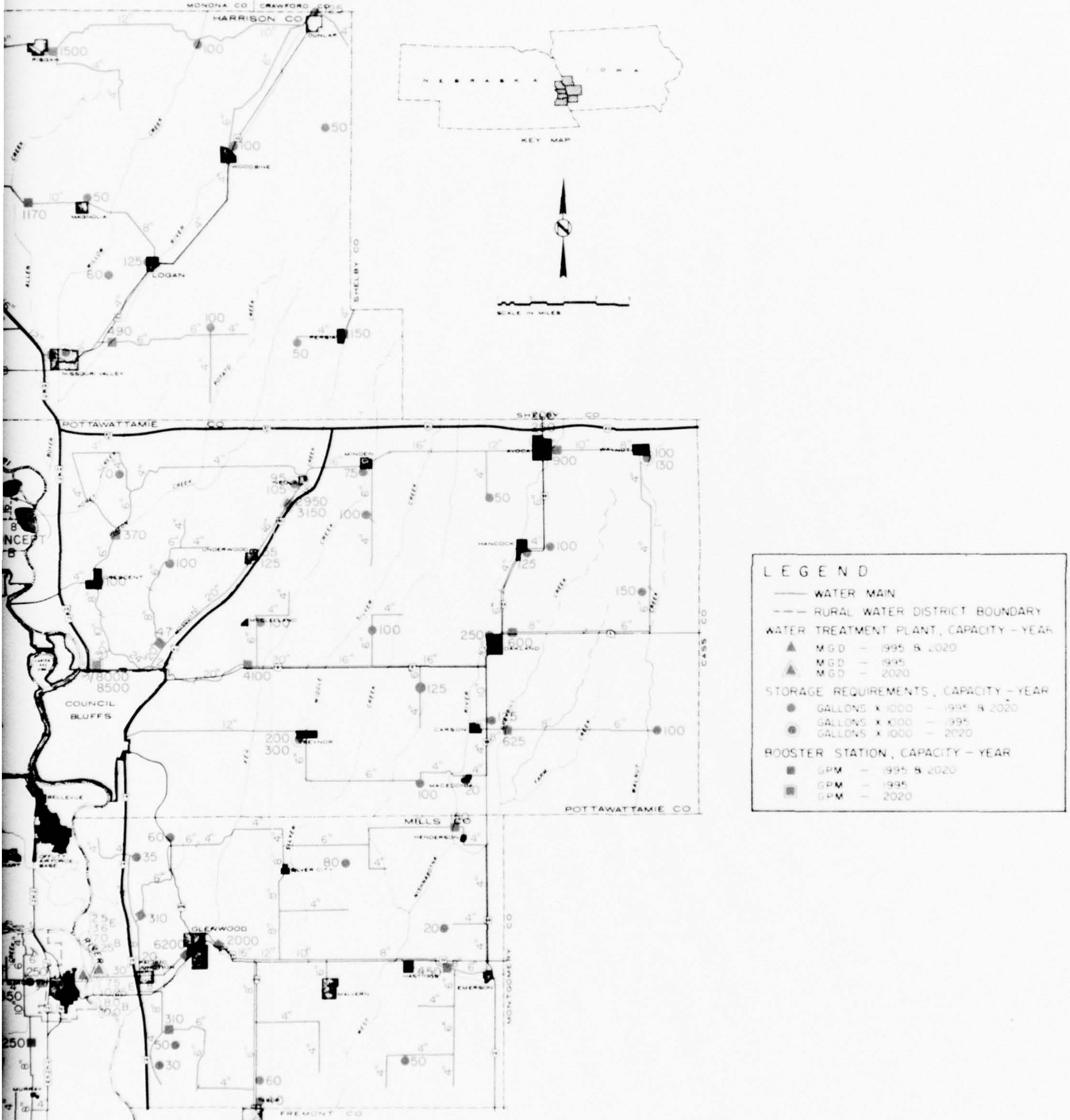


REGIONAL WATER SUPPLY

PLAN II NON-METROPOLITAN

U.S. ARMY DISTRICT OMAHA

CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE VI - 6

2

County from the Council Bluffs treatment plant in Water Supply Plan II. A new booster pumping station with a 2020 capacity of 12.0 mgd located in northern Council Bluffs will pump a major portion of rural demands with the remainder pumped by other Council Bluffs pumping stations. The new booster station as well as other features of the County's Plan II distribution system are shown in Figure VI-6. Capacity of the Council Bluffs treatment plant will vary with Growth Concept, however non-metropolitan water needs supplied by the Council Bluffs plant will be 6.50 mgd in all Concepts. Council Bluffs will also supply the 1.50 mgd needs of the new town East Bellevue in Concept B.

Mills County. A single treatment plant and river intake at Pacific Junction is evaluated as the supply source for Mills County in Plan II. The treatment facility will have a 2020 capacity of 10.25 mgd and an average daily pumpage of 6.11 mgd in Growth Concept E and 10.00 and 5.25 mgd in Concept B. The distribution system with three major west to east supply routes is shown in Figure VI-6.

Cass County. Extension of rural water district service to the towns of Nehawka, Union and Weeping Water is assumed in Plan II. Supply

and pumping facilities for Cass County RWD 1 and Otoe County RWD 3 are enlarged accordingly. The treatment plant at Greenwood is eliminated in Plan II in favor of a larger, 2020 capacity of 2.0 mgd and average treatment of 1.00 mgd, facility at Louisville supplying the remainder of the county.

Metropolitan Area. Development of Water Supply Plan II for each of the four Growth Concepts is shown in Figures VI-8 through VI-11. Plan II treatment facilities for the metropolitan area are summarized in Table VI-8.

TABLE VI-8

PLAN II TREATMENT PLANTS-METROPOLITAN AREA

Location	Growth Concept	2020 Capacity(mgd)	2020 Av. Treatment(mgd)
Florence	A	240	109.66[1]
	B	255	118.53[1]
	C	260	121.98[1]
	D	235	108.88[1]
Platte River South	A	80	34.01
	B	60	23.12
	C	75	32.65
	D	75	32.46
Platte River West	A	175	73.73
	B	120	55.74
	C	135	60.17
	D	170	72.64
Council Bluffs	A	38.0	16.97[1]
	B	37.5	16.20[1]
	C	37.0	16.28[1]
	D	40.5	17.58[1]

[1] Portion of plant pumpage going to metropolitan area.

Douglas-Sarpy County. "Plan B" from MUD's Master Plan is the basis for development of a system supplying all metropolitan areas of Douglas and Sarpy Counties in Plan II. It is assumed that the "Platte West" site can be developed to the extent planned by the Master Plan. As indicated in the section on supply sources, some form of flow stabilization in the Platte River will be required to guarantee

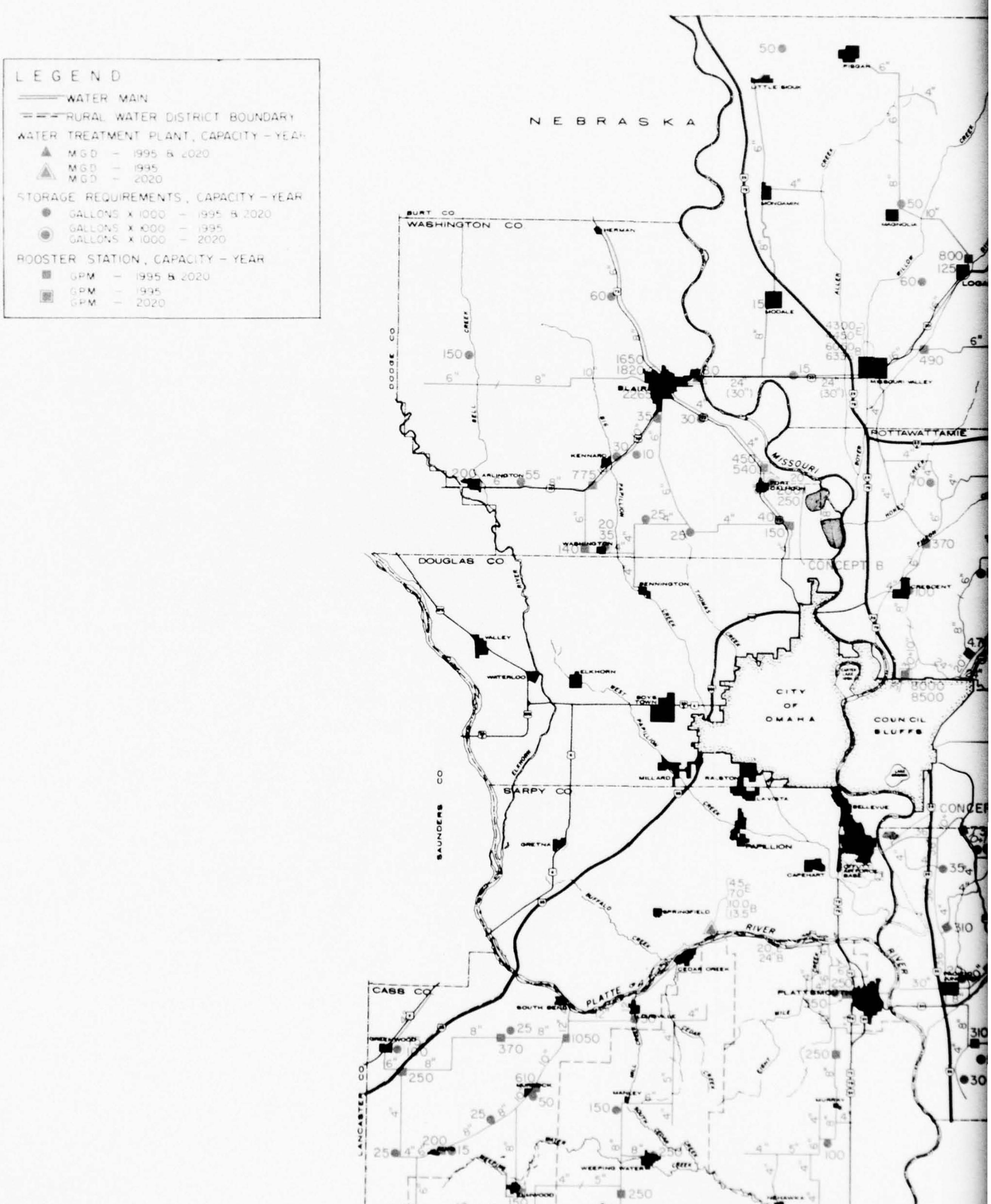
reliability of this source. All communities and adjacent rural users in the two counties will be served by the MUD system.

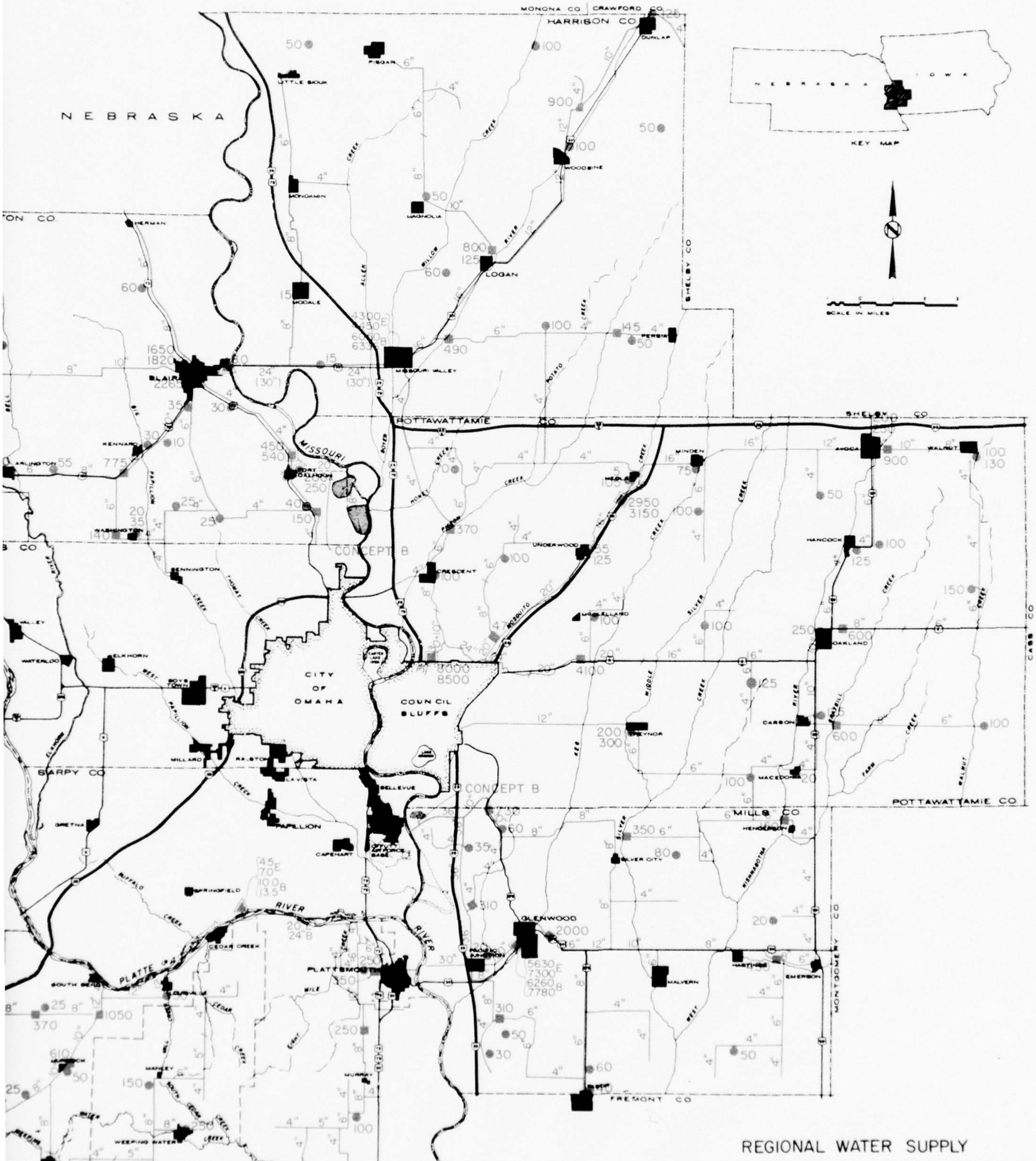
Council Bluffs. The only change in the Council Bluffs system from Plan I to II is increased supply to rural Pottawattamie County. Treatment and pumping capacity is expanded to meet demands of the entire county.

Plan III

Water Supply Plan III is characterized by maximum centralization and regionalization of water supply and distribution facilities. Six treatment plants serve the entire seven county area. It is envisioned that state and utility autonomy will be retained by wholesale of water from the entity controlling treatment plant operation to the nontreating user. While system capacity and configuration is still largely on a county basis, interconnection of pipine networks at county lines will provide maximum reliability and flexibility.

Non-metropolitan Area distribution system for Plan III is shown in Figure VI-7. Treatment plants serving non-metropolitan areas are summarized in Table VI-9.


LEGEND
WATER MAIN
RURAL WATER DISTRICT BOUNDARY
WATER TREATMENT PLANT, CAPACITY - YEAR
MGD - 1995 & 2020
MGD - 1995
MGD - 2020
STORAGE REQUIREMENTS, CAPACITY - YEAR
GALLONS X 1000 - 1995 & 2020
GALLONS X 1000 - 1995
GALLONS X 1000 - 2020
BOOSTER STATION, CAPACITY - YEAR
GPM - 1995 & 2020
GPM - 1995
GPM - 2020
NEBRASKA
BURT CO
WASHINGTON CO
DODGE CO
DOUGLAS CO
SAUNDERS CO
SARPY CO
CASS CO
LANCASTER CO
OTOE CO
POTTAWATTAMIE
MISSOURI
PLATTE RIVER
CITY OF OMAHA
COUNCIL BLUFFS
CONCEPT B
BLAIR
MISSOURI VALLEY
PAPILLION
GRETNA
SPRINGFIELD
PLATTSMOUTH
WEEPING WATER



REGIONAL WATER SUPPLY

PLAN III NON-METROPOITAN

U.S. ARMY DISTRICT OMAHA

CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE VI - 7

2

TABLE VI-9

PLAN III TREATMENT PLANTS-NON-METROPOLITAN AREA

Location	Source	2020 Capacity(mgd)	2020 Av. Treatment(mgd)
Blair	Surface	14.5[2]	7.7[2]
	Surface	28.0[3]	14.8[3]
Council Bluffs	Surface	34.0 to 38.5[4]	5.68[1]
Missouri South	Surface	145 to 185[4]	6.11[1,2]
	Surface	130[3]	6.72[1,3]
Spring-field	Ground	7.0[2]	3.03[1,2]
	Ground	13.5[3]	6.52[3]

[1]Portion of plant pumpage going to non-metropolitan area.

[2]Growth Concepts A, C, and D.

[3]Growth Concept B.

[4]Depends upon Growth Concept.

Washington County. The Washington County system is identical to Plan I except treatment facilities at Blair are expanded to serve Harrison County and the southern portion of the system is interconnected with the MUD network.

Harrison County. All of Harrison County's requirements are met by the treatment facility at Blair in Plan III. Major distribution piping networks run generally northeastward from a river crossing at the Blair Toll Bridge. Pipelines cross into Pottawattamie County

at Harrison County's southern border.

Pottawattamie County. Water supply to Pottawattamie County is basically the same in Plan III as in Plan II with Council Bluffs supplying the bulk of water needs. A small portion of extreme southwestern Pottawattamie County including the Growth Concept B new town of East Bellevue is served by the MUD Missouri River South Plant. Pipeline connections also cross into Harrison and Mills County.

Mills County. A river crossing at the Bellevue Bridge from MUD's Missouri River South Plant supplies water to Mills County in Plan III. Nearly seven miles of 36-inch pipeline to the principal water user (Glenwood) make the economics of this system questionable.

Cass County. Distribution systems for Cass County are the same in Plan II and Plan III. A single treatment plant near Springfield in Sarpy County and transmission lines to Louisville and Plattsmouth replace treatment facilities in these two towns. Otoe County RWD 3 and Cass County RWD 2 remain supplied from Otoe County.

Metropolitan Area. System configuration for each of the four Growth Concepts is shown in Figures VI-8 through VI-11. Plan II metropolitan area treatment facilities are summarized in Table VI-10.

TABLE VI-10

PLAN III TREATMENT PLANTS-METROPOLITAN AREA

Location	Plan	2020 Capacity (mgd)	2020 Av. Treatment (mgd)
Florence	A	235	109.66
	B	255	118.53
	C	260	121.98
	D	235	108.88
Missouri South	A	185	74.38[1]
	B	130	56.01[1]
	C	145	60.45[1]
	D	180	73.55[1]
Platte South	A	80	34.01
	B	60	23.12
	C	75	32.65
	D	75	32.46
Council Bluffs	A	36.5	15.50[1]
	B	34.0	13.61[1]
	C	36.5	15.18[1]
	D	38.5	15.85[1]

[1] Portion of plant pumpage going to metropolitan area.

Douglas and Sarpy Counties. In Plan III, Douglas and Sarpy counties are served from three treatment facilities: Florence, Platte River South, and Missouri River South. This Plan evaluates service to all urban and adjacent rural areas of the county with the Missouri River South site developed for the third major treatment facility in place of the Platte River West site of Plan II. Again, water availability considerations dictate use of the Missouri River source in place

of the more desirable Platte source. Location of the Missouri River South site also facilitates service of an entire non-metropolitan county (Mills) from a major urban plant.

Service reliability of non-metropolitan systems is greatly enhanced by inter-connection with the MUD system. Connections occur along the Douglas-Washington County line, at the non-metropolitan Springfield treatment plant and between the Pottawattamie County network and the MUD supplied Mills County system.

Council Bluffs. As in Plan II the Council Bluffs system supplies Pottawattamie County, with the exception of a small extreme southwestern portion of the county. The Concept B new Town of East Bellevue in Mills County is also not served by Council Bluffs. Non-metropolitan reliability and flexibility is improved via interconnection with the Council Bluffs system and meshing of networks at county lines.

Plan IV

The four alternative nonpotable supply sources discussed earlier in this section are evaluated for use in a dual potable-nonpotable system in Plan IV. It was initially determined that either of two levels of nonpotable service, out-of-house only or out-of-house plus toilet flushing, in areas of substantial new development might prove feasible.

To test the applicability of a dual system in the study area, water requirements and costs are computed for use of a nonpotable supply and distribution system for residential out-of-house and in-house toilet flushing uses in developing areas of Omaha in Growth Concepts A and C. Fire flow requirements will also be provided by the nonpotable system.

The higher level of nonpotable service which includes toilet flushing is the most economically feasible since potable water consumption and therefore treatment costs are reduced with minor increases in distribution system cost. Since the nonpotable distribution system must be sized to meet a lawn sprinkling peak to average demand ratio of up to 11 to 1 and to supply fire flows, little additional system capacity is required for toilet flushing demands. Concepts A and C are evaluated as extremes in out-of-house water usage and expanse of dual piping network.

Table VI-11 lists design flows for a nonpotable system serving area of new growth in metropolitan Omaha only. Computation of potable system savings versus nonpotable system costs using each nonpotable supply source and Table VI-11 nonpotable demands is performed in the next chapter of this report. Results indicate no financial benefit from use of a dual system. Since water availability from traditional

TABLE VI-11
NONPOTABLE WATER REQUIREMENTS [1]

Growth Concept	OUT-OF-HOUSE ONLY				OUT-OF-HOUSE & TOILET FLUSHING			
	1995		2020		1995		2020	
	Daily Usage (mgd)		Daily Usage (mgd)		Daily Usage (mgd)		Daily Usage (mgd)	
	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
A	5.69	35.96	11.45	72.43	11.58	45.70	21.10	88.95
B	1.92	12.06	2.99	18.79	4.49	16.27	6.49	24.50
C	2.19	13.75	4.78	30.00	5.44	19.07	10.36	39.09
D	5.06	31.94	10.48	66.14	10.52	40.95	19.71	81.34

[1] New growth areas of metropolitan Omaha only.

sources in the study area does not dictate use of non-traditional sources within the study period, dual water systems are not considered feasible.

Alternative Growth Concepts.

In non-metropolitan areas, the satellite cities and new towns of Concept B impose increased or new loads on the supply and distribution system. The effect is evaluated readily in terms of increased facility size and supply and new and/or enlarged pipelines.

In metropolitan areas, Growth Concept evaluation becomes more difficult since both demand magnitude and location are affected. Supply and distribution systems for each Supply Plan are shown by Growth Concept in Figures VI-8 through VI-11.

To determine the effect of Growth Concept on facility size, usage, and ultimately cost, areas of demand are assigned. Figure VI-12 shows metropolitan Omaha divided into eight water use areas. Council Bluffs is similarly divided into four demand zones. Demands within these areas are computed (see Section III) for each Growth Concept and areas or portions of areas are supplied by a particular treatment facility and booster pumping station (if needed) in each Supply Plan.

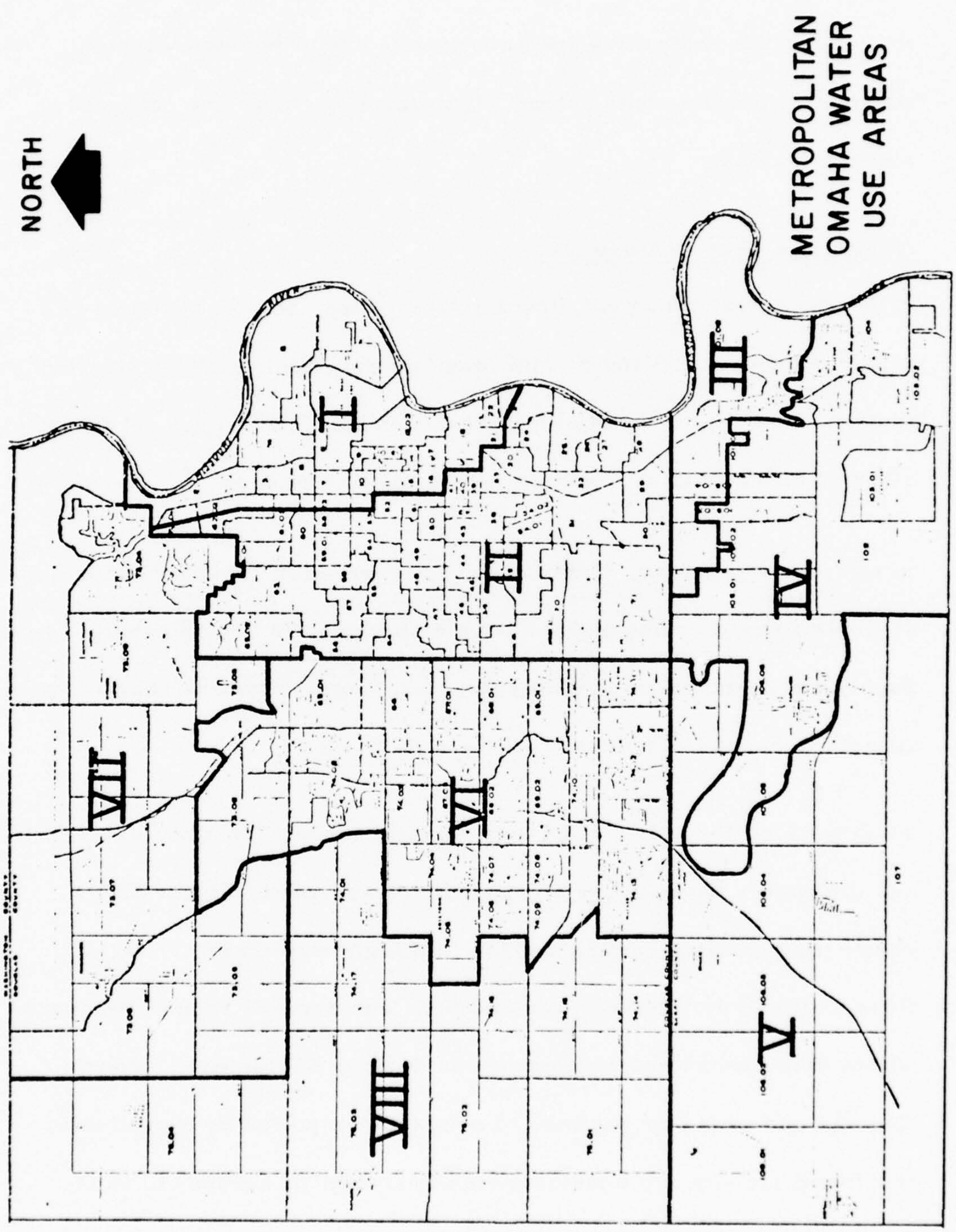
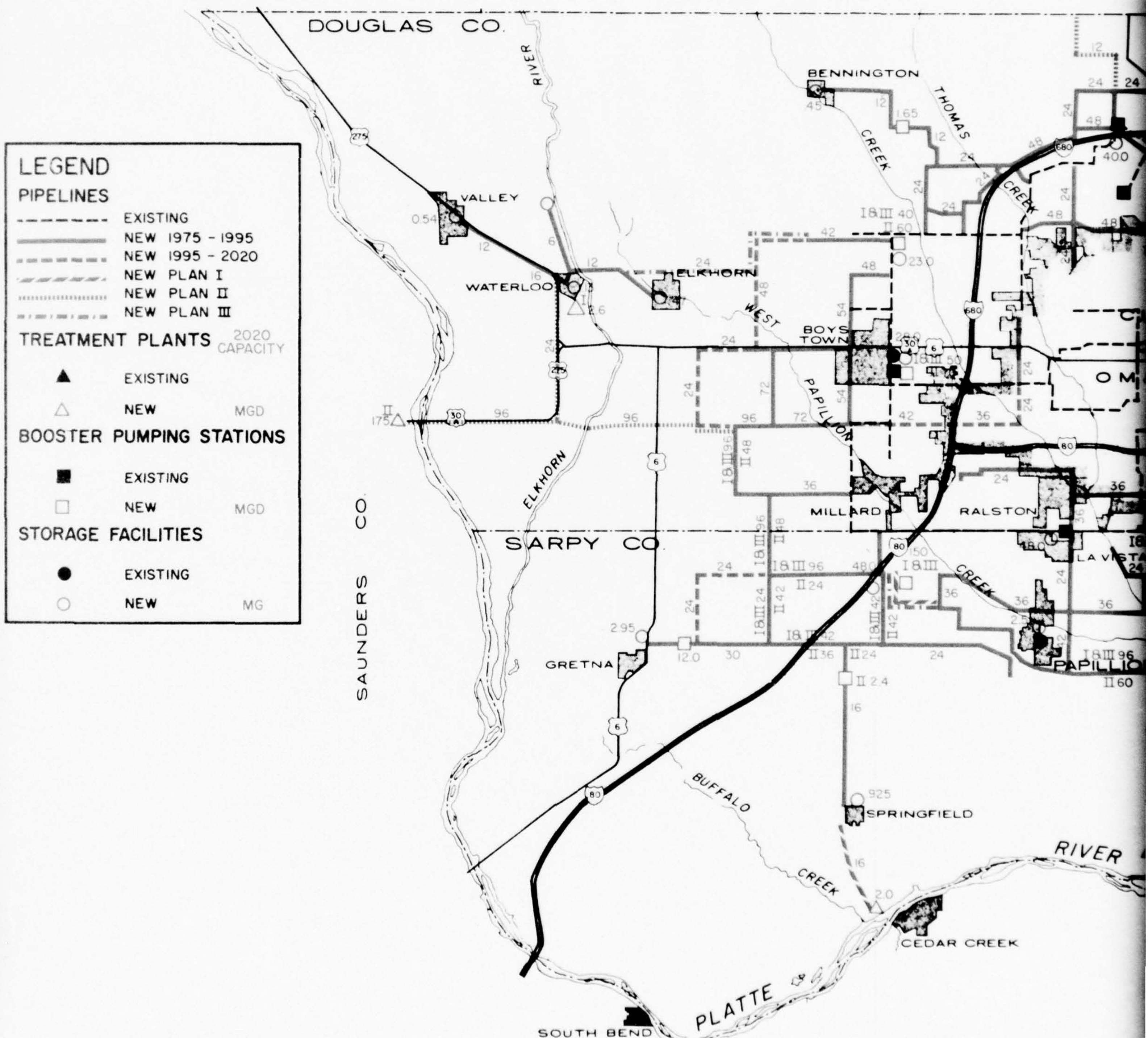
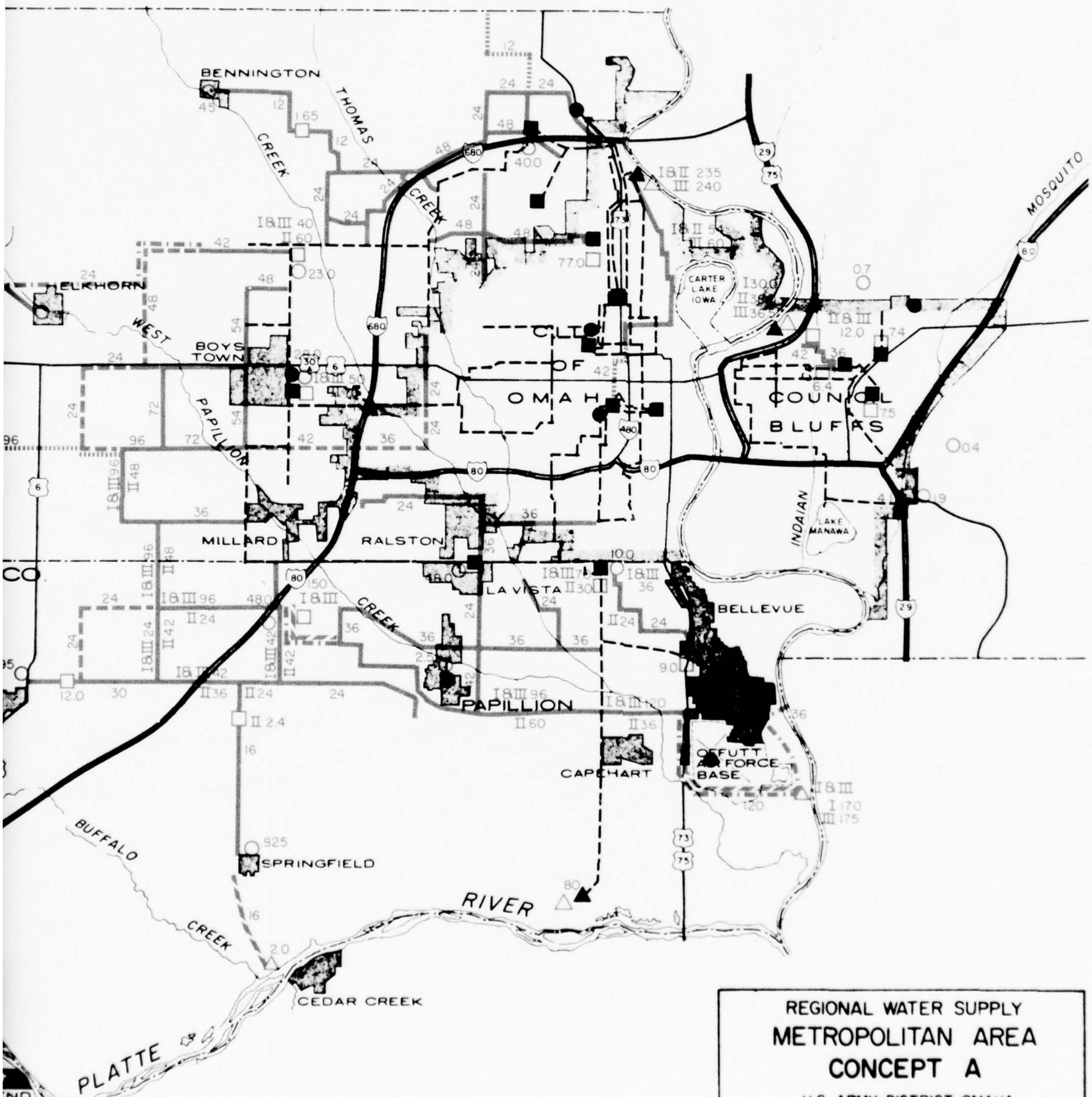

NORTH
METROPOLITAN
OMAHA WATER
USE AREAS
I
II
III
IV
V
VI
VII
VIII

FIGURE VI - 12

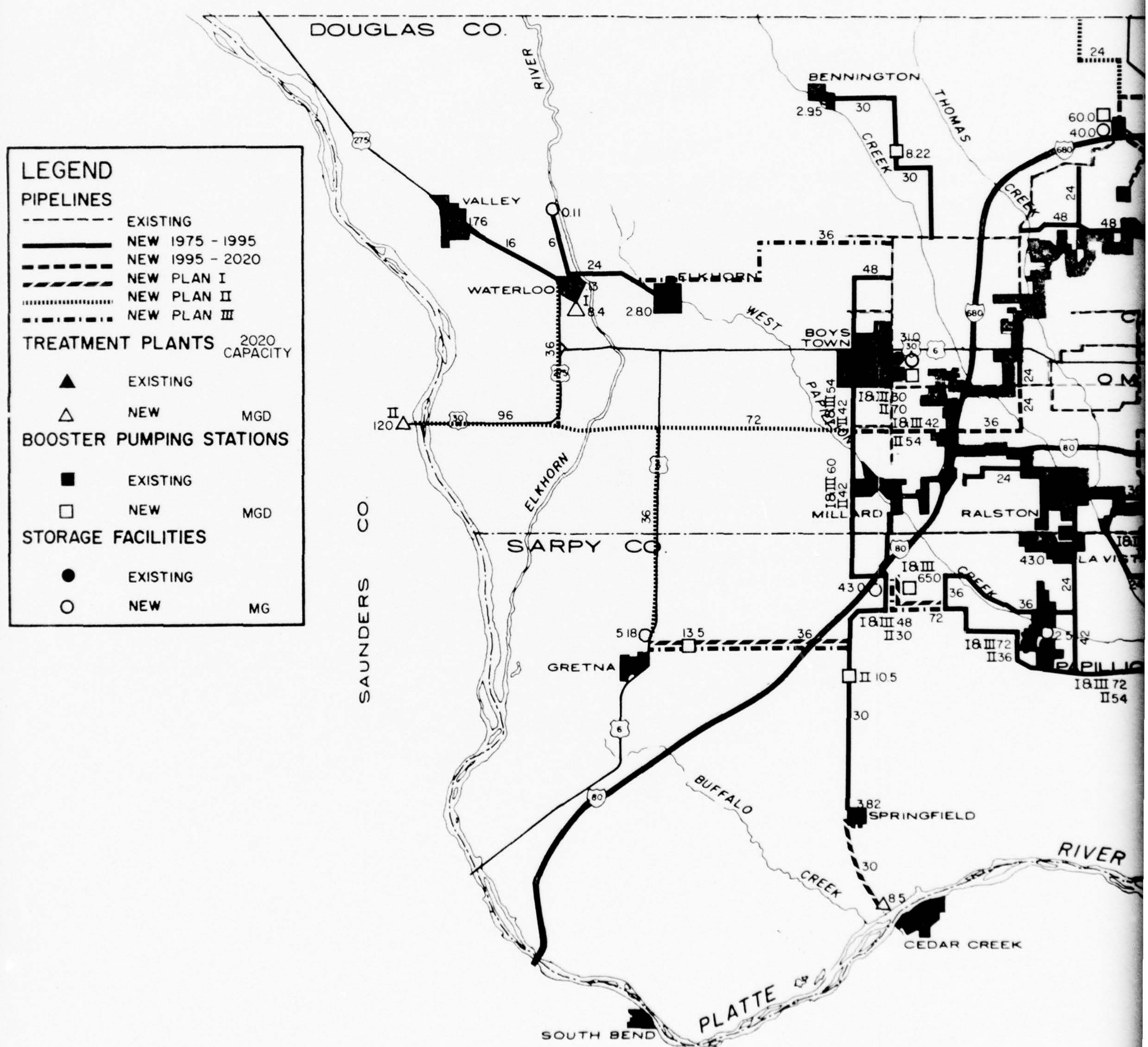

LEGEND
PIPELINES
EXISTING
NEW 1975 - 1995
NEW 1995 - 2020
NEW PLAN I
NEW PLAN II
NEW PLAN III
TREATMENT PLANTS
2020 CAPACITY
EXISTING
NEW
MGD
BOOSTER PUMPING STATIONS
EXISTING
NEW
MGD
STORAGE FACILITIES
EXISTING
NEW
MG
DOUGLAS CO.
SARPY CO.
SAUNDERS CO.
BENNINGTON
VALLEY
WATERLOO
ELKHORN
BOYS TOWN
MILLARD
RALSTON
LA VISTA
PAPILLION
GRETNA
SPRINGFIELD
CEDAR CREEK
SOUTH BEND
ELKHORN RIVER
THOMAS CREEK
WEST PAPILLION CREEK
BUFFALO CREEK
PLATTE RIVER

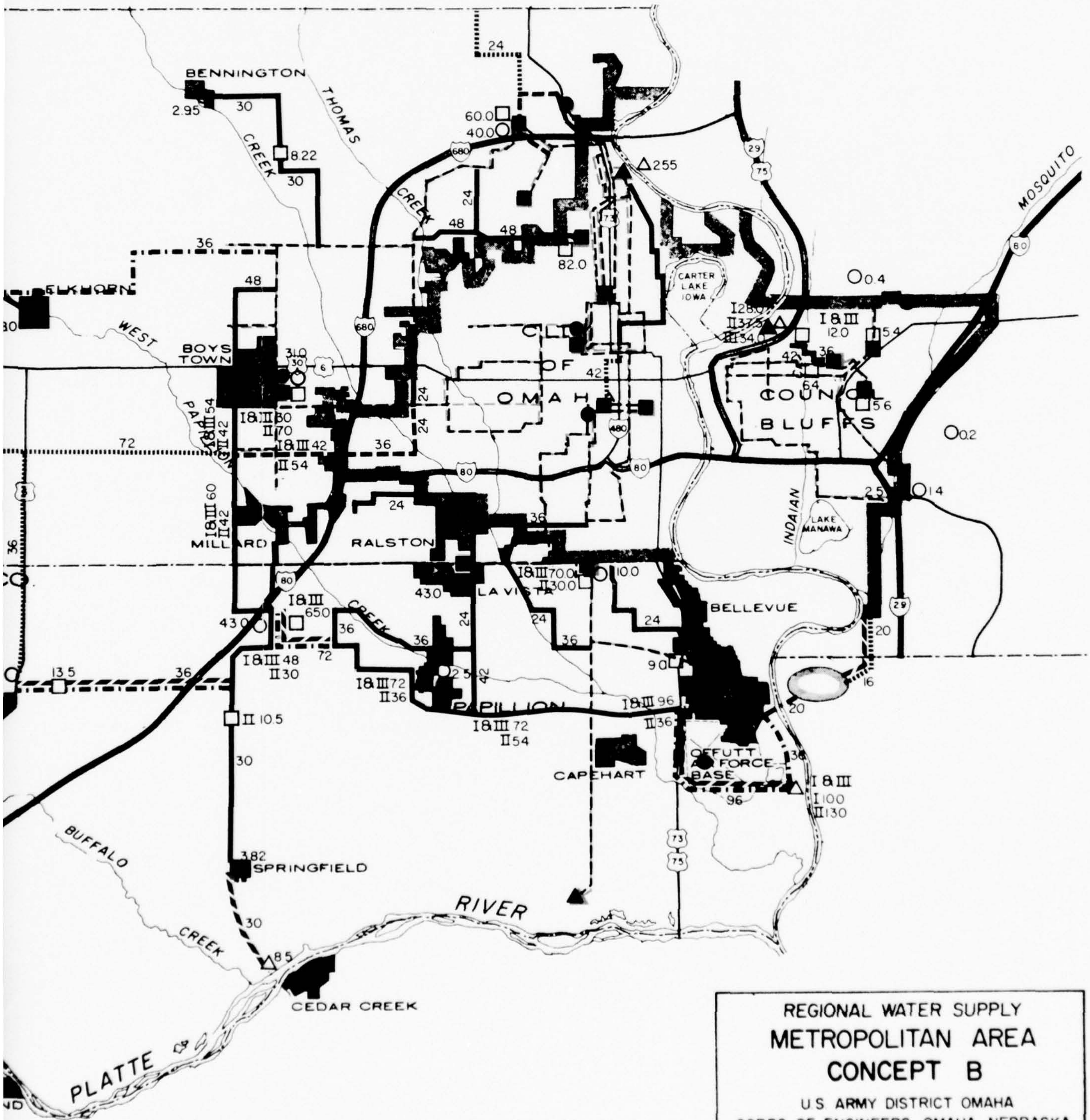


REGIONAL WATER SUPPLY
METROPOLITAN AREA
CONCEPT A
U.S. ARMY DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE VI - 8

2


LEGEND
PIPELINES
EXISTING
NEW 1975 - 1995
NEW 1995 - 2020
NEW PLAN I
NEW PLAN II
NEW PLAN III
TREATMENT PLANTS
2020 CAPACITY
EXISTING
NEW
MGD
BOOSTER PUMPING STATIONS
EXISTING
NEW
MGD
STORAGE FACILITIES
EXISTING
NEW
MG
DOUGLAS CO.
SARPY CO.
SAUNDERS CO.
VALLEY
WATERLOO
ELKHORN
BENNINGTON
BOYS TOWN
MILLARD
RALSTON
LA VISTA
PAPILLION
GRETNA
SPRINGFIELD
CEDAR CREEK
SOUTH BEND
ELKHORN RIVER
WEST PAPIO
THOMAS CREEK
BUFFALO CREEK
PLATTE RIVER



REGIONAL WATER SUPPLY

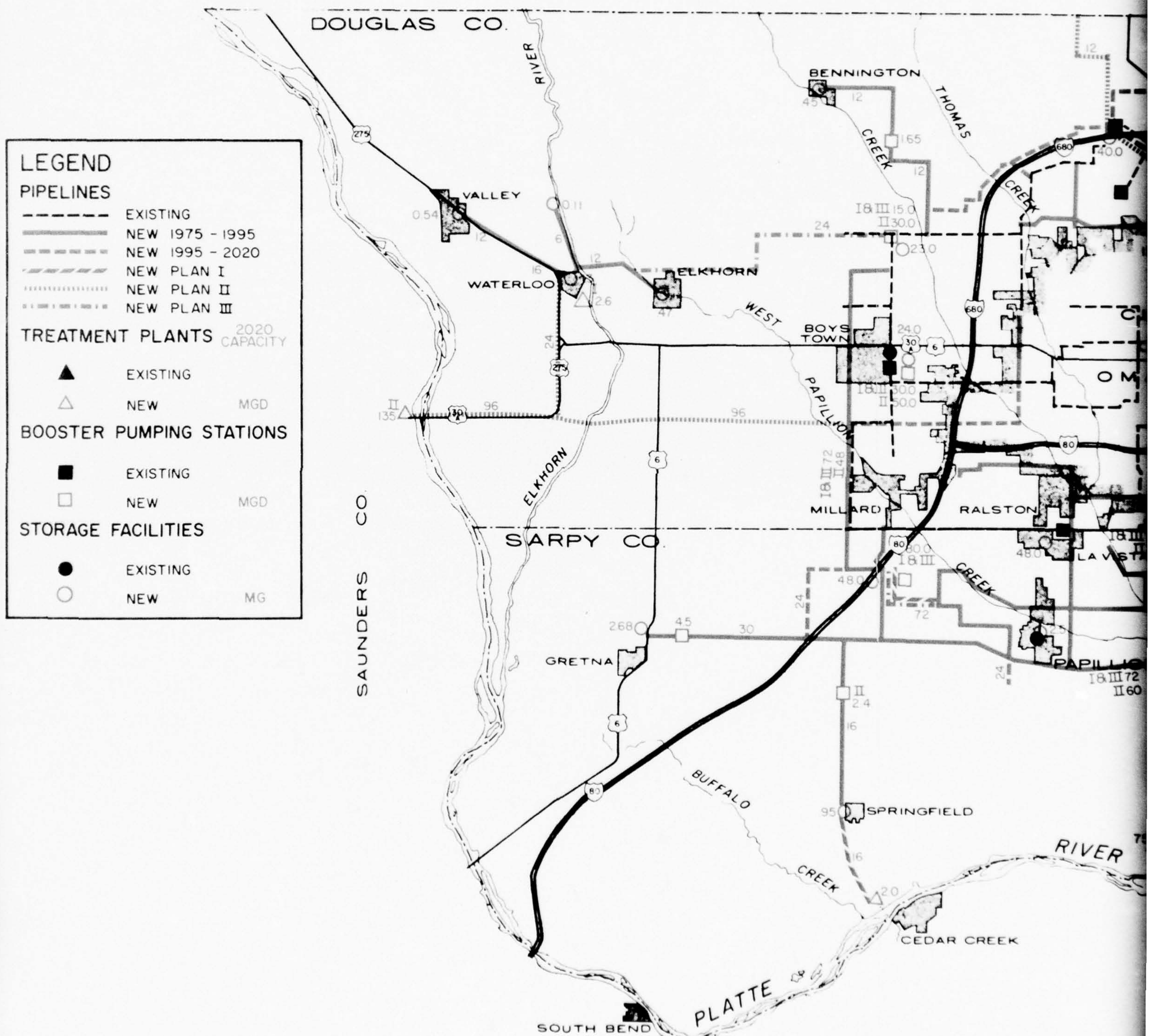
METROPOLITAN AREA

CONCEPT B

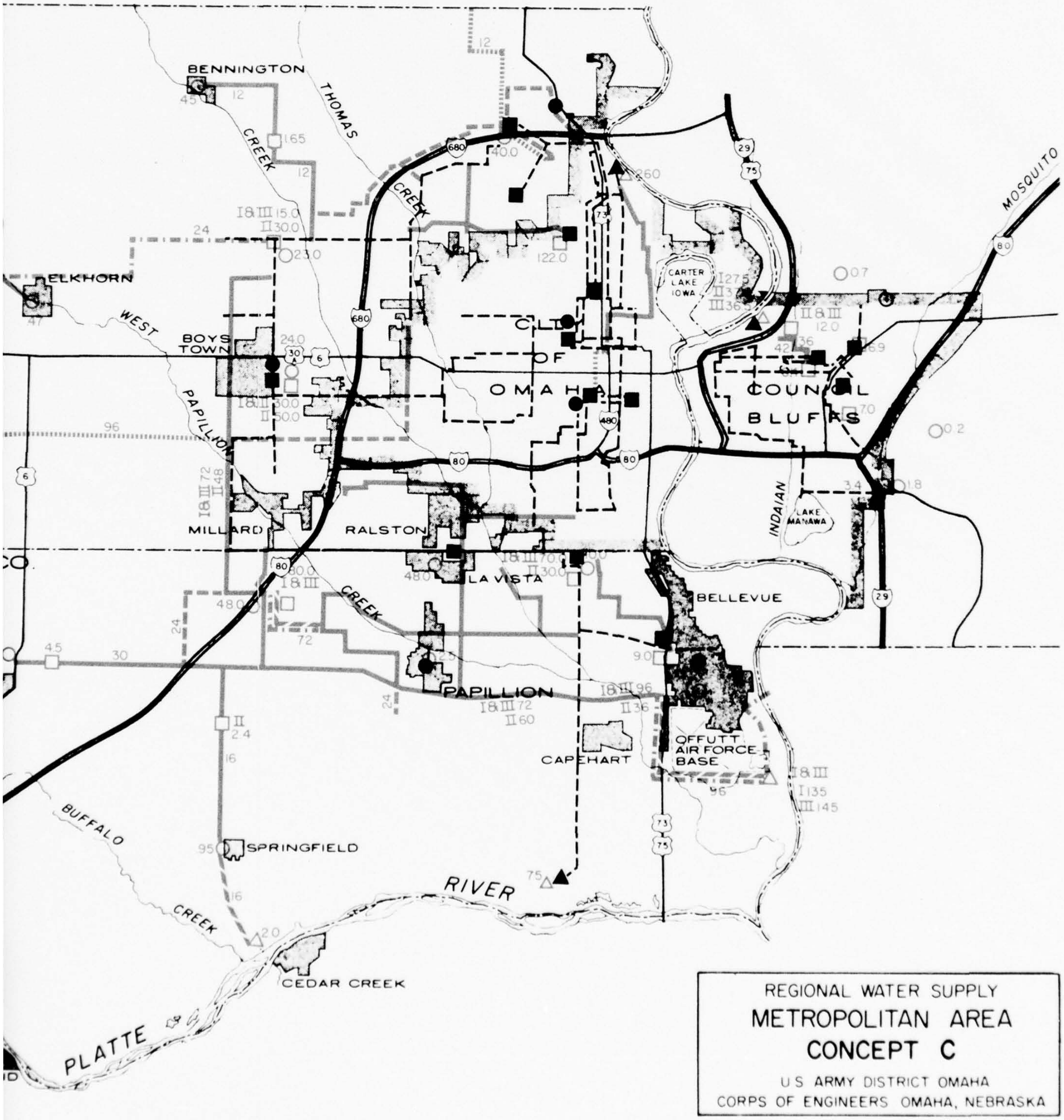
U.S. ARMY DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE VI - 9

2



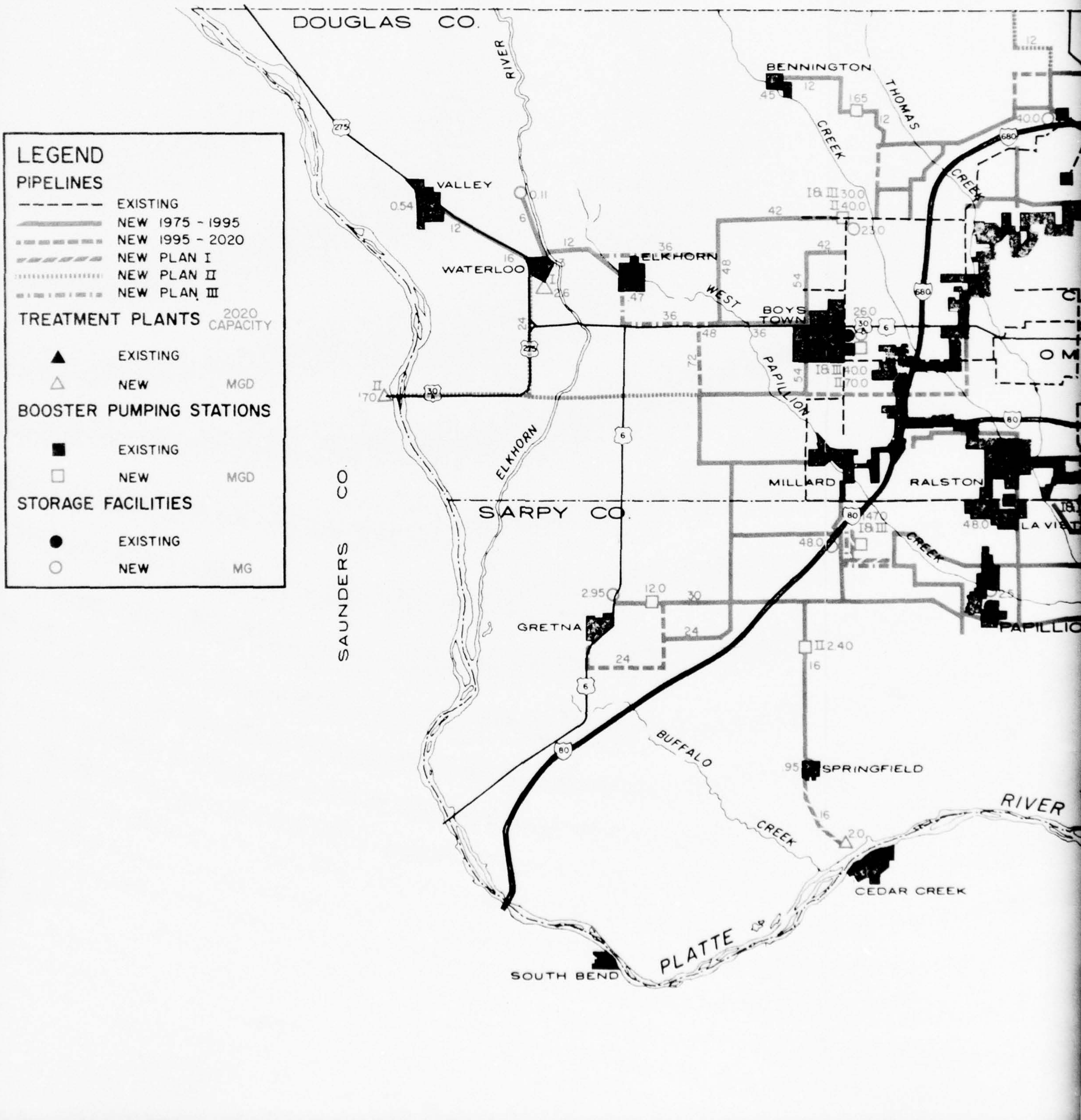
LEGEND
PIPELINES
EXISTING
NEW 1975 - 1995
NEW 1995 - 2020
NEW PLAN I
NEW PLAN II
NEW PLAN III
TREATMENT PLANTS
2020 CAPACITY
EXISTING
NEW
MGD
BOOSTER PUMPING STATIONS
EXISTING
NEW
MGD
STORAGE FACILITIES
EXISTING
NEW
MG
DOUGLAS CO.
SARPY CO.
SAUNDERS CO.
VALLEY
WATERLOO
ELKHORN
BENNINGTON
BOYS TOWN
MILLARD
RALSTON
GRETNA
SPRINGFIELD
CEDAR CREEK
SOUTH BEND
PAPILLION
LA VISTA
OM
ELKHORN RIVER
THOMAS CREEK
WEST PAPILLION CREEK
BUFFALO CREEK
PLATTE RIVER



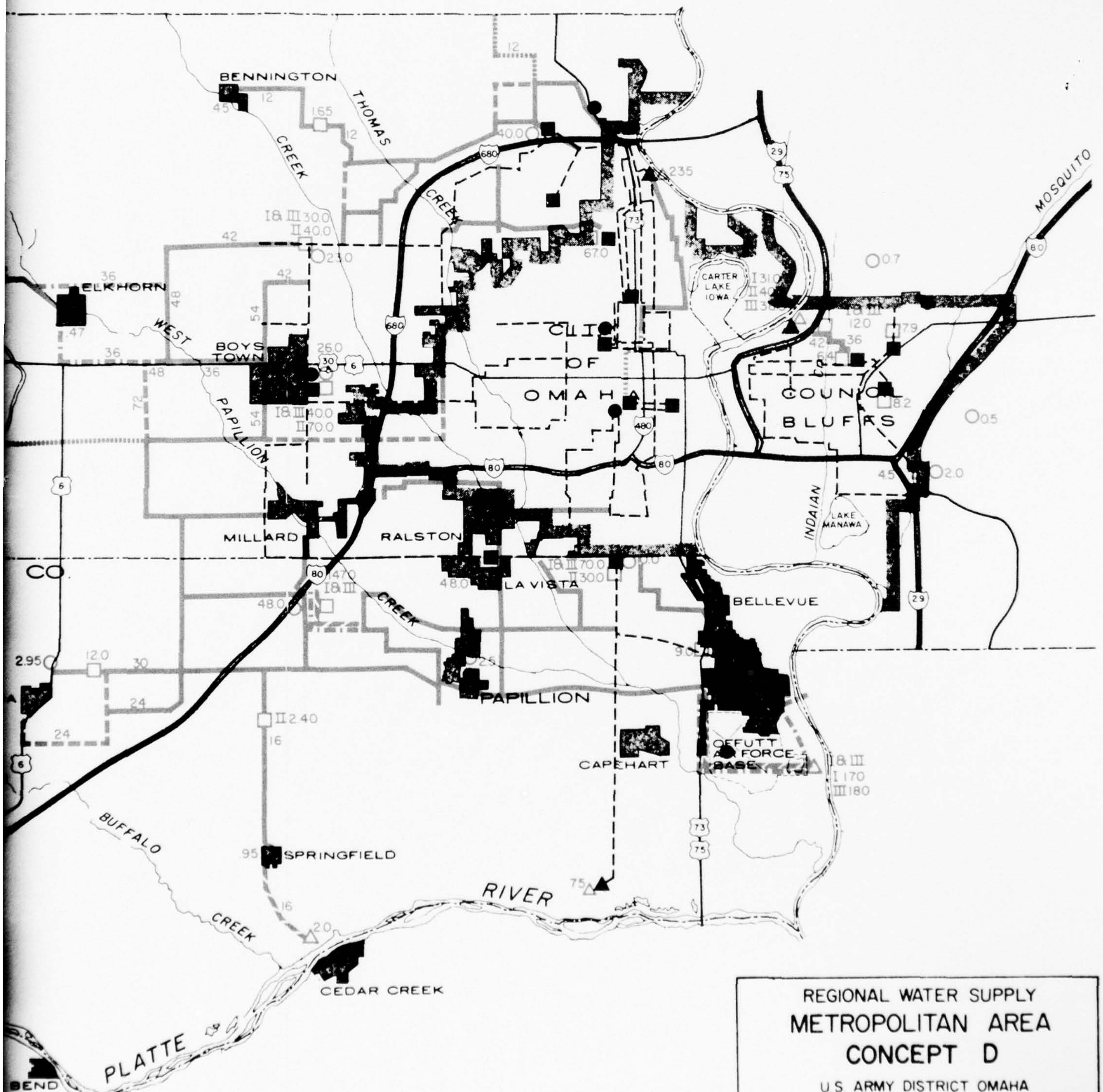
REGIONAL WATER SUPPLY
METROPOLITAN AREA
CONCEPT C
U.S. ARMY DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE VI - 10

2



LEGEND
PIPELINES
EXISTING
NEW 1975 - 1995
NEW 1995 - 2020
NEW PLAN I
NEW PLAN II
NEW PLAN III
TREATMENT PLANTS
2020 CAPACITY
EXISTING
NEW
MGD
BOOSTER PUMPING STATIONS
EXISTING
NEW
MGD
STORAGE FACILITIES
EXISTING
NEW
MG
DOUGLAS CO.
SARPY CO.
SAUNDERS CO.
BENNINGTON
VALLEY
WATERLOO
ELKHORN
BOYS TOWN
MILLARD
RALSTON
GRETNA
SPRINGFIELD
CEDAR CREEK
SOUTH BEND
PAPILLION
ELKHORN RIVER
THOMAS CREEK
WEST PAPILLION CREEK
BUFFALO CREEK
PLATTE RIVER



REGIONAL WATER SUPPLY
METROPOLITAN AREA
CONCEPT D
U.S. ARMY DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE VI - 11

For example, areas assumed served by the Platte West treatment plant in Plan II and the Missouri South plant in Plan III include Area V, Area VIII and 2/3 of Area VI. All water supplied to these areas V and VIII by the Missouri South plant in Plan III must be repumped by the I-80 booster pumping station while a large portion of the area can be served direct from the Plan II Platte West plant. Thus pumping costs are higher for service to westerly portions of Omaha in Plan III (and Plan I) than in Plan II. Less consumption in outlying areas in Growth Concepts B and C due to reduced and constrained growth respectively lessen the pumping cost differential between Plans as well as reducing piping network extent and size.

Lesser sprawl in Concepts B and C generally lessen all system component costs. For instance, the MUD Fort Street pumping station is not needed in Concept B. One cost which increases is service to outlying communities. Pipelines built specifically to these communities increase in length as the urban fringe is constrained and increase in size where the community is a Concept B satellite city.

<u>System Flexibility.</u> It is highly unlikely that a water supply and distribution system can be developed in such a manner as to promote definitely one of the four growth alternatives. Even if the economics

of water supply and distribution strongly favor a particular growth concept, water is only one of many factors which must be considered. Presence of the Missouri River eliminates water availability as a major problem in the study area. Cost of water to the individual, at least in metropolitan Omaha-Council Bluffs, is insignificant compared to other essentials such as housing and transportation.

Thus it is probable that the water supply and distribution system will affect growth patterns only if used in conjunction with housing transportation, industrial, and/or sewer development. Assuming growth patterns are controlled, population growth uncertainties would still affect water system development.

In all probability, at least in the short term, water supply and distribution systems must maintain flexibility with respect to both location and quantity of demands. Conservative design is a means of assuring system flexibility in light of these uncertainties. Pipeline, pumping, storage and treatment facilities designed with expansion in mind or slightly oversized for projected demands may not be cost-effective if the projections are correct but very few areas of demands exceeding projections are needed to make conservative design more

practical than paralleling or expansion of lesser capacity facilities. Staged construction will also aid in system flexibility since adjustments can be made to accommodate changes in needs.

Preparation of a Master Plan similar to Council Bluffs and the Omaha Metropolitan Utilities District prevents development of a haphazard system which is short-sighted in needs with resulting loss of flexibility.

SECTION VII

ECONOMIC ANALYSES

SECTION VII

ECONOMIC ANALYSES

This chapter describes methods and results of cost and economic analyses performed for this study. Section D of Appendix 1 contains a complete description and listing of data generated by the computer program used for computing cost and present worth of the various supply plans.

CAPITAL COST METHODOLOGY

Cost curves have been developed for treatment plants, water treatment sludge handling facilities, storage facilities, pumping stations, and pipelines. Unit costs generated from historical construction costs, recent Omaha area biddings, and suppliers' quotes were normalized to September, 1974, based upon Engineering News Record cost indices. Contingencies for engineering, legal, administrative and unforeseen costs are not included in cost curves presented in this chapter.

Treatment Plants

Several factors are incorporated into total treatment plant construction cost. Basic treatment plant costs as shown in Figure VII-1 are for either iron and manganese removal and softening of ground water, or presedimentation, sedimentation, and softening of surface water followed by filtration and chlorination. A river intake cost of $70,000

TREATMENT PLANT CAPITAL COST

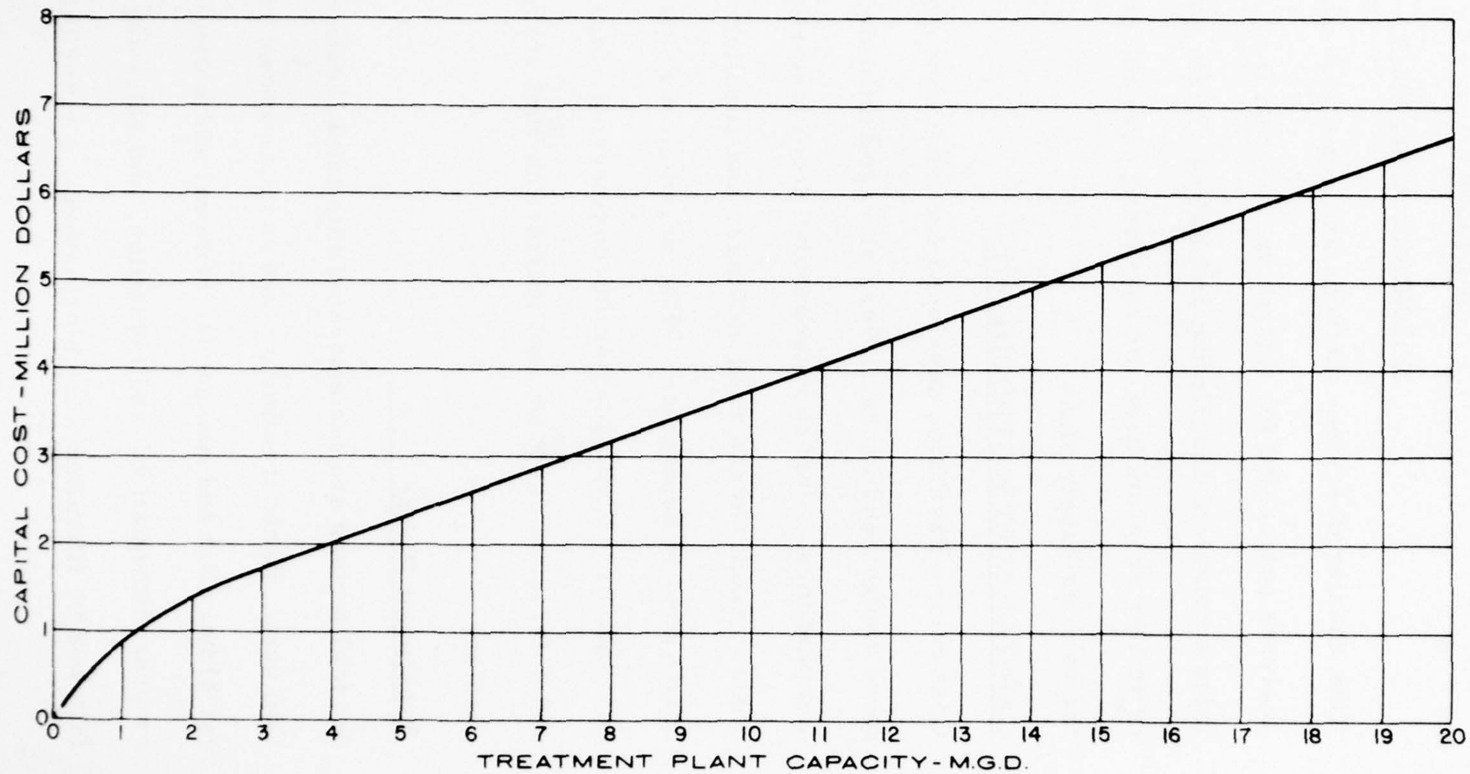


FIGURE VII-1

per mgd capacity is additional for surface water sources. Because of highly varying yields from aquifers within the study area, well fields for small (less than 5 mgd) ground water treatment plants are costed based upon the probable number of wells required to provide a firm well capacity equivalent to treatment capacity. A per well cost of $70,000 for wells of less than 1000 gpm capacity and $80,000 for wells of greater than 1000 gpm capacity is used. Intermediate capacity well field costs are $70,000 per mgd capacity.

Above 20 mgd maximum capacity (Council Bluffs and MUD plants) a cost of $345,000 per mgd capacity includes well field or river intake.

Water treatment plant waste sludge handling facility construction costs are shown in Figure VII-2. Design criteria upon which these costs are based are given in Chapter VI.

Land costs are not included in treatment plant, well field or river intake, or sludge handling facility costs.

Booster Pumping Stations

Construction cost of booster pumping stations varies substantially with size and location. Rural water district pumping stations are

WATER TREATMENT SLUDGE HANDLING FACILITIES
CAPITAL COST

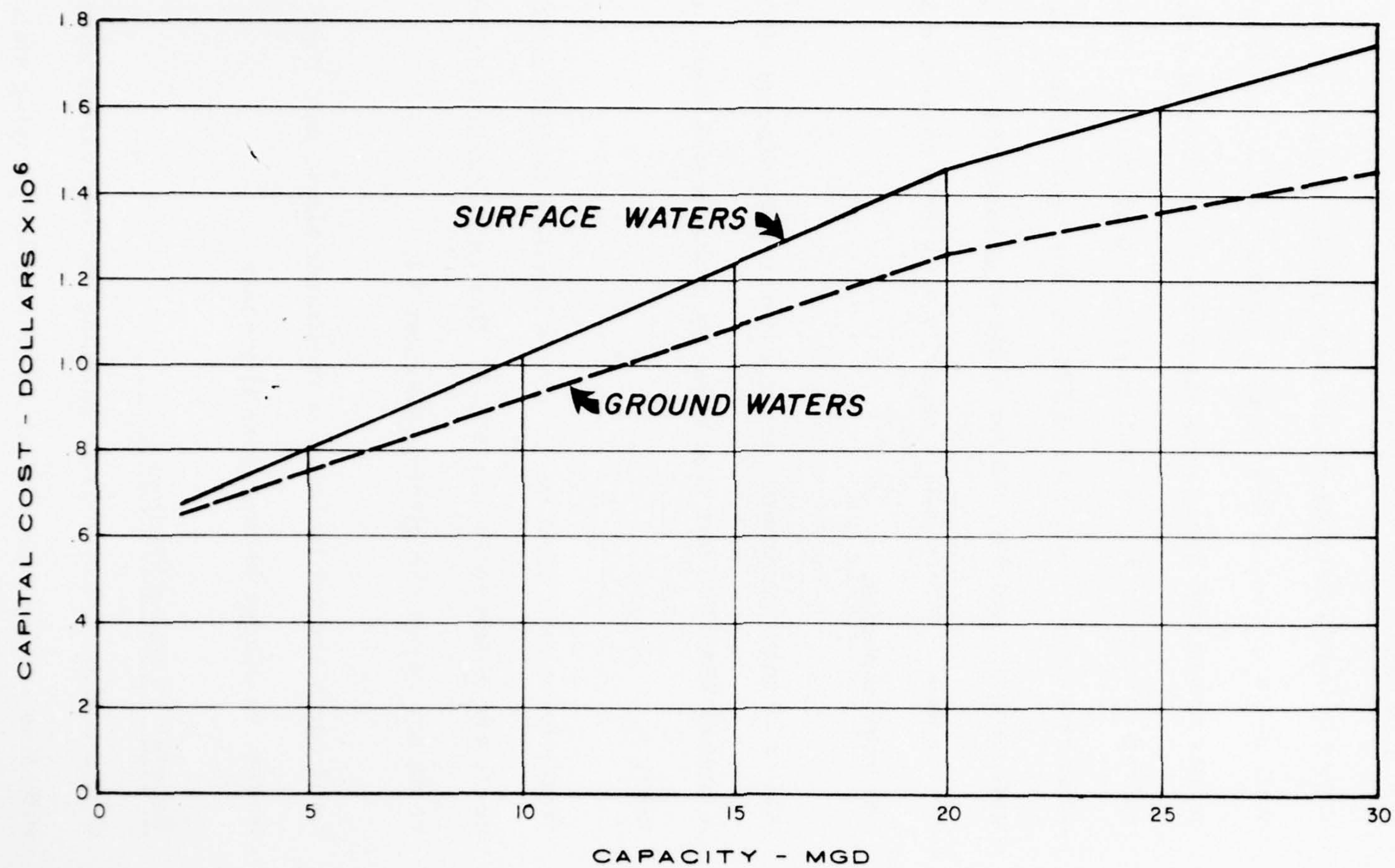


FIGURE VII - 2

simple in design and construction resulting in a substantially lower unit cost than those in a metropolitan system. Highly sophisticated pump control networks which optimize operational efficiency and reliability are necessary and cost-effective in the metropolitan systems but not in rural water districts. For these reasons, two cost curves as shown in Figures VII-3 and VII-4 are used in cost determination of metropolitan and rural booster pumping stations, respectively. A unit cost of $23,000 per mgd capacity is used for pumping stations 40 mgd and larger.

Storage Facilities

Figures VII-5 through VII-8 show cost of elevated, standpipe, steel ground level and concrete ground level storage facilities respectively. Appurtenant piping, sitework, and controls are included in these costs.

Pipelines

Materials of construction normally used and site conditions affect pipeline costs. Polyvinyl chloride (PVC) piping commonly used in rural water districts reduces installed pipeline costs although less significantly at the present than historically. Fewer obstructions and greater freedom of location also lower rural area installation costs.

As discussed in Chapter VI, rural water district distribution piping

METROPOLITAN BOOSTER STATION
CAPITAL COST

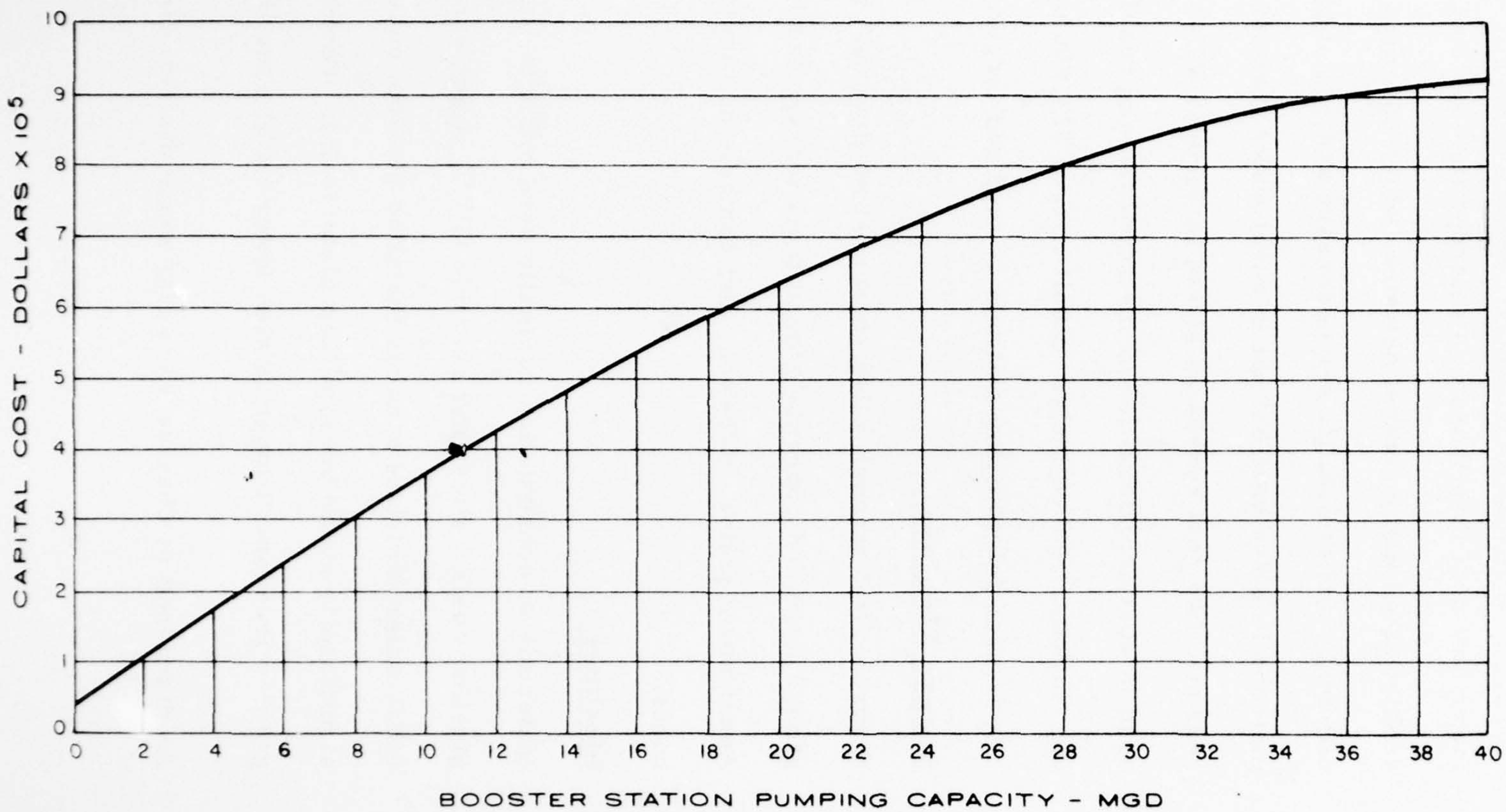


FIGURE VII - 3

RURAL BOOSTER STATION
CAPITAL COST

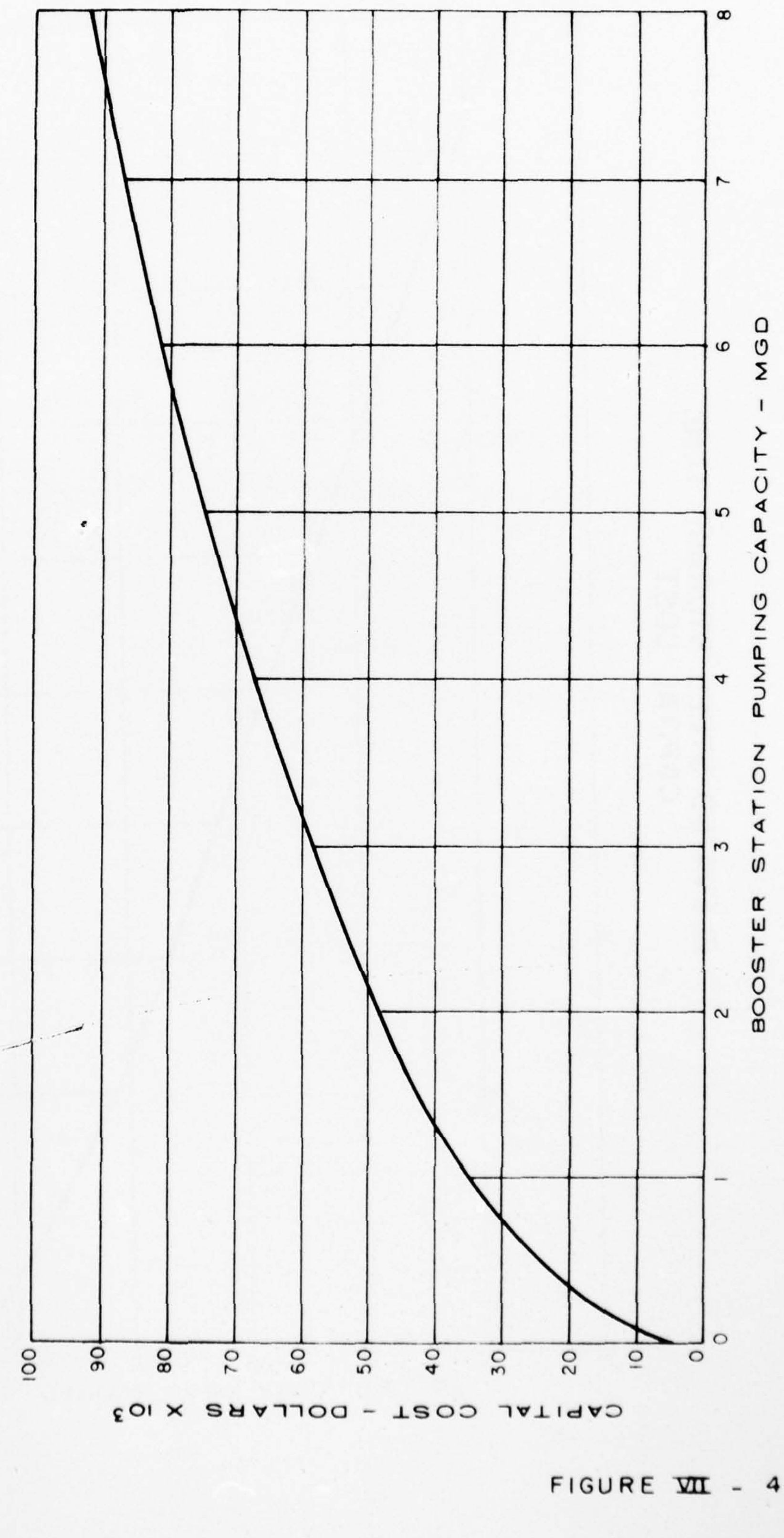


FIGURE VII - 4

ELEVATED STEEL STORAGE TANK
CAPITAL COST

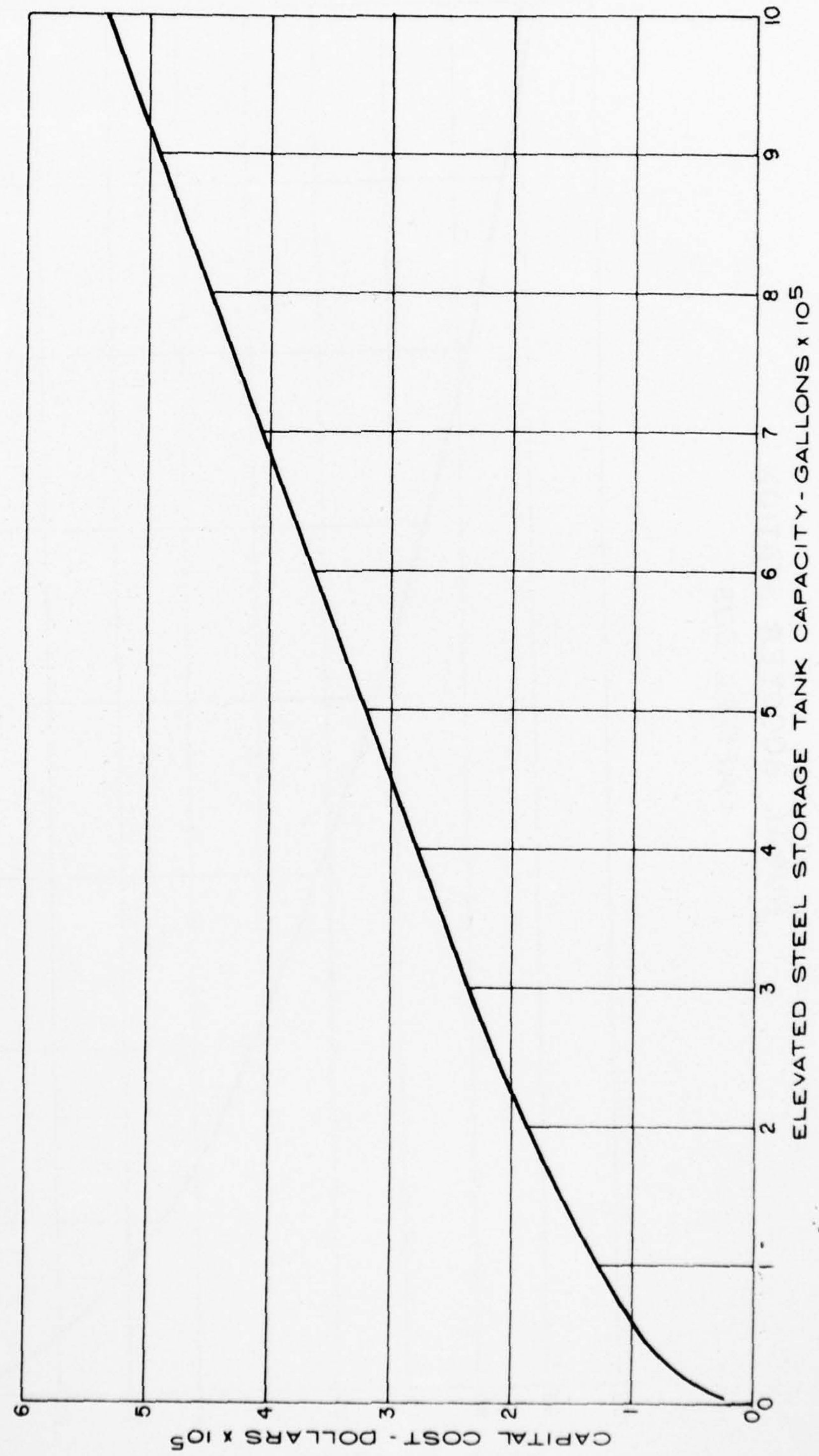


FIGURE VII-5

STEEL STANDPIPE STORAGE TANK CAPITAL COST

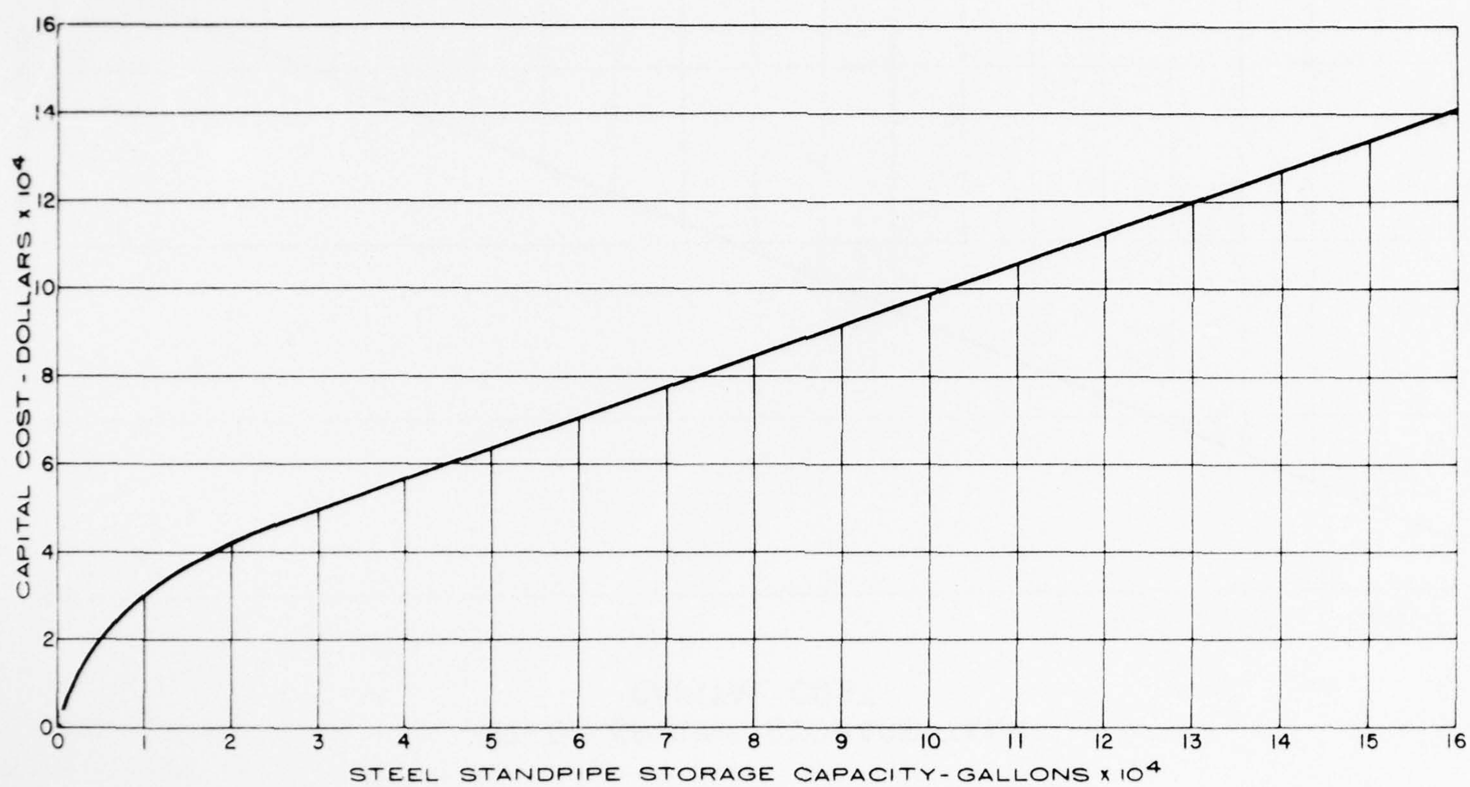


FIGURE VII-6

STEEL GROUND STORAGE TANK
CAPITAL COST

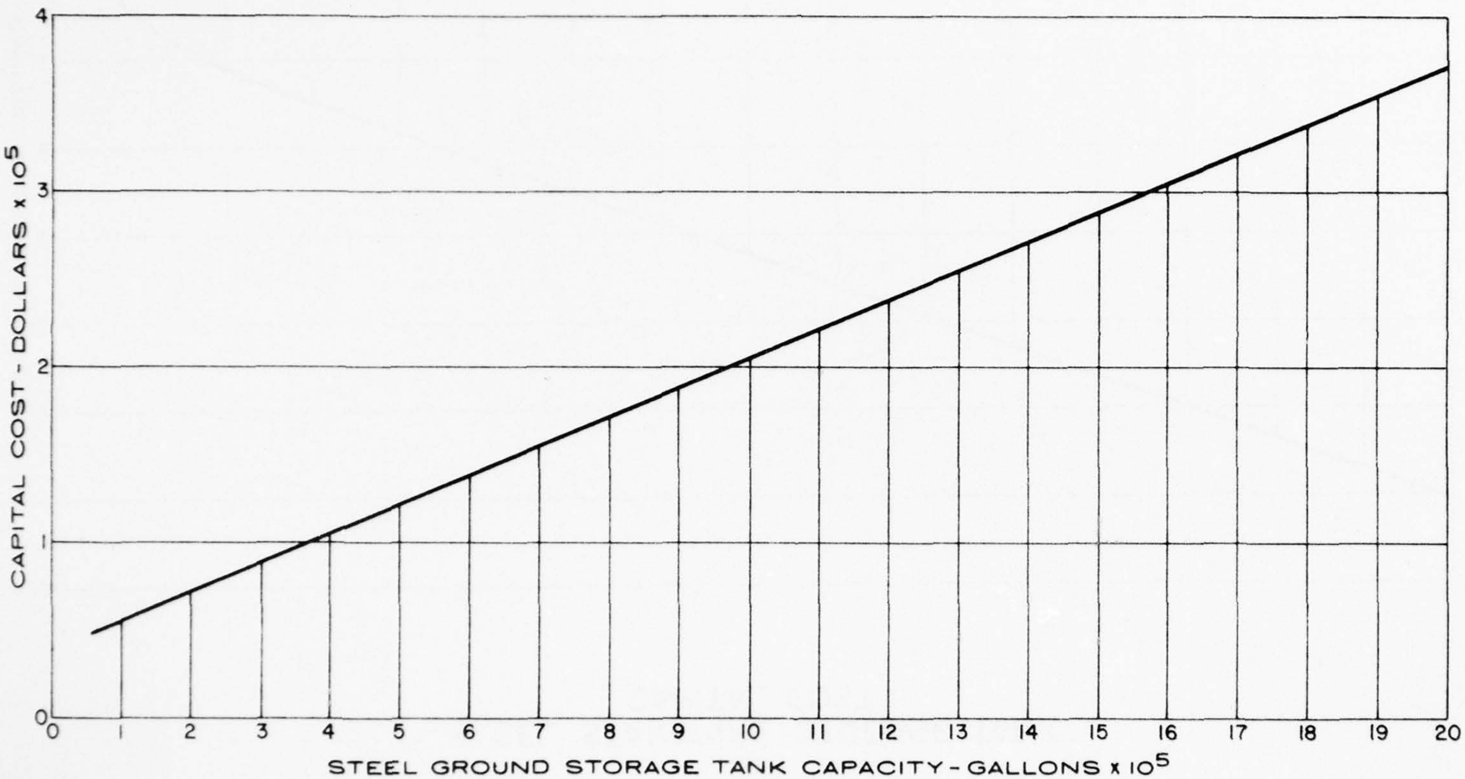


FIGURE VII - 7

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WATER AND RELATED LAND RESOURCES MANAGEMENT STUDY. VOLUME V. SU--ETC(U)
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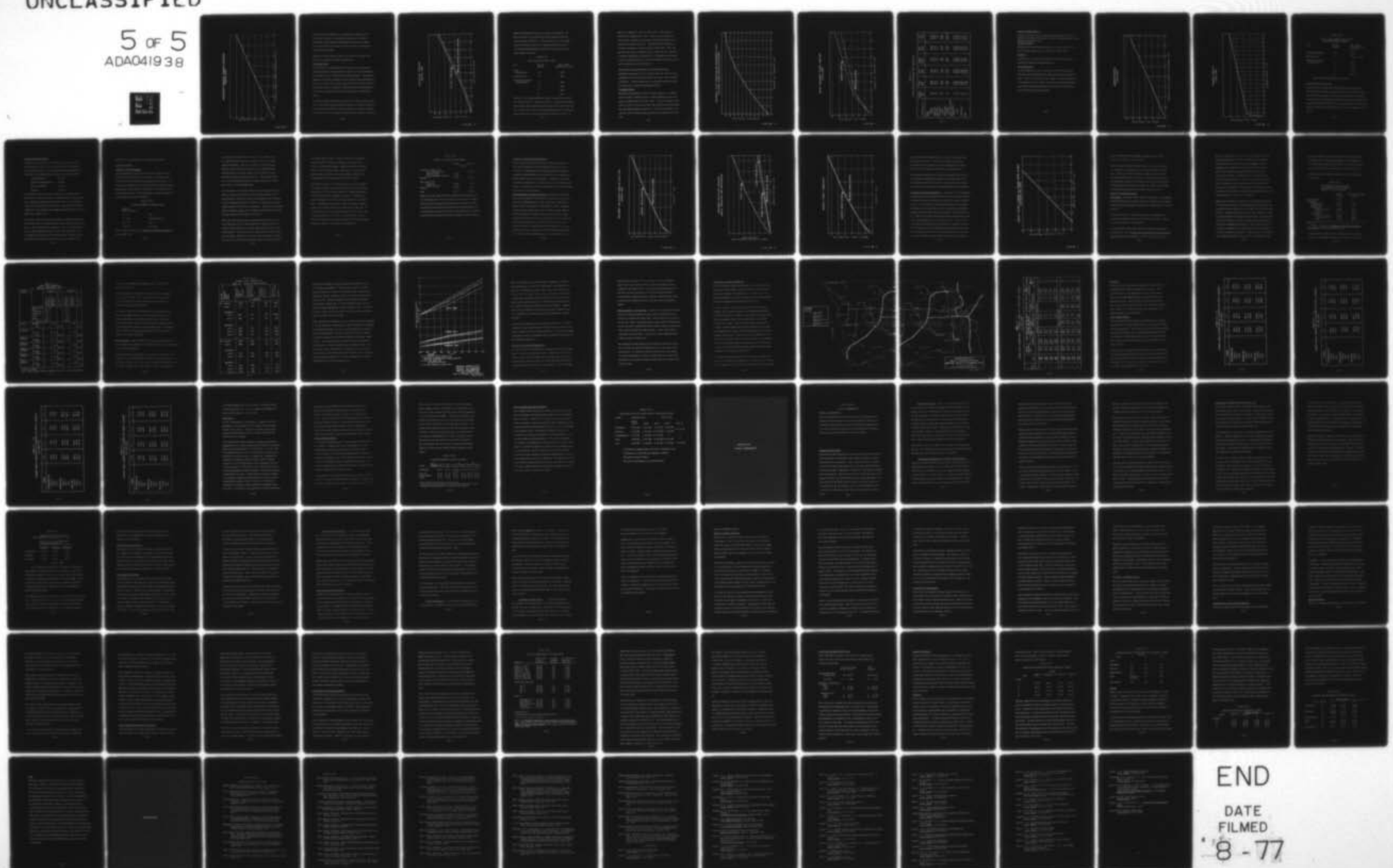

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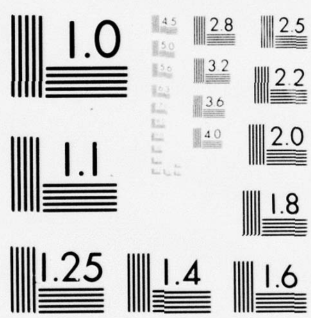


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

REINFORCED CONCRETE STORAGE RESERVOIR
CAPITAL COST

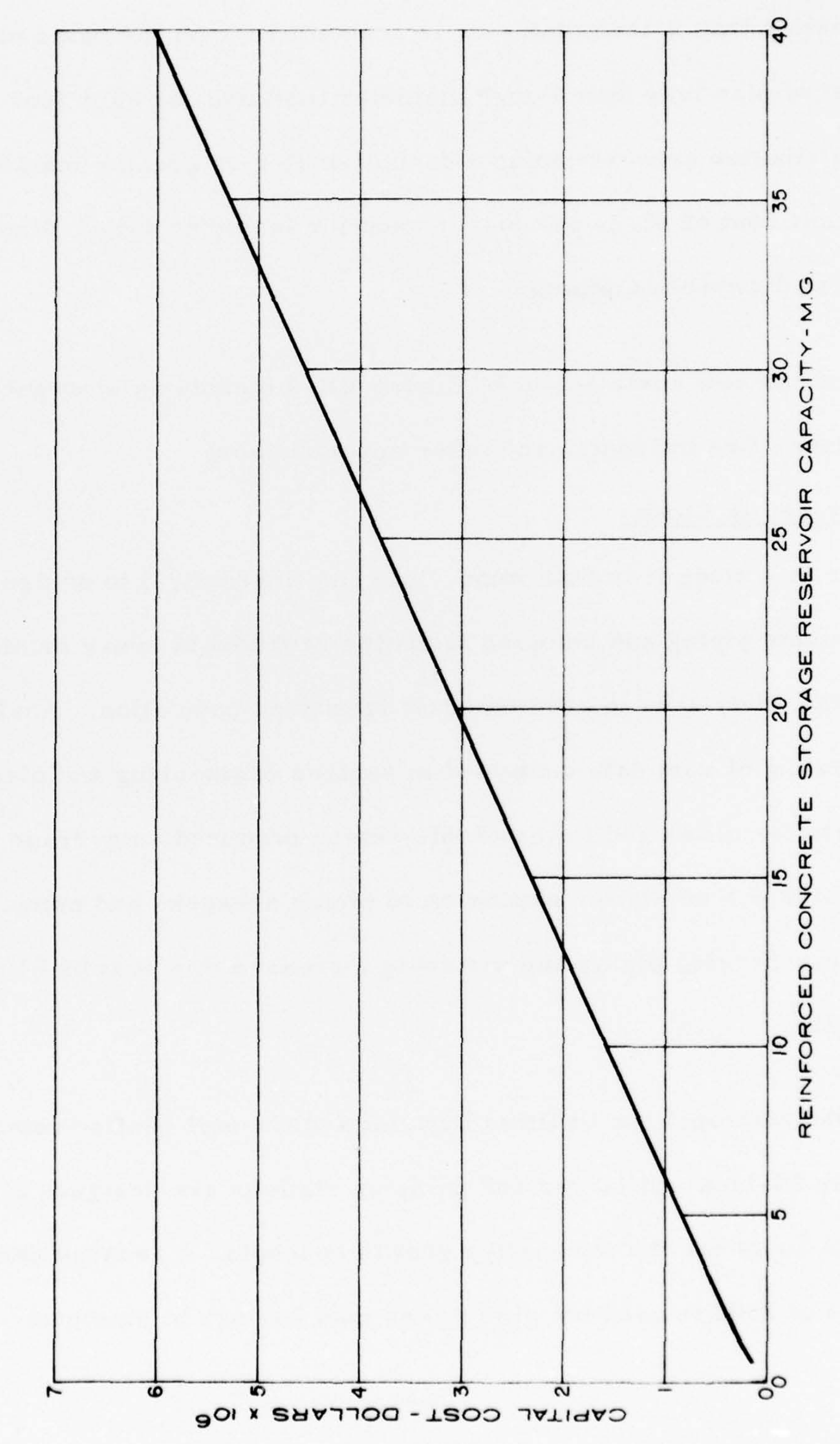


FIGURE VII-8

smaller than 4-inch diameter is accounted for on the basis of 4 feet of pipe less than 4-inch diameter installed for each foot of distribution network piping 4-inch diameter or greater installed. A unit cost of $2.25 per foot is used for less than 4-inch diameter rural distribution piping.

Pipeline unit costs shown in Figure VII-9 include an allowance for valves, fire hydrants, and other appurtenances.

Per Capita Costs

For this study it is both impossible and impractical to design and evaluate piping and pumping facilities required in every municipality in the study area to accommodate increased population. Analysis and updating of cost data contained in various engineering and planning reports for cities and towns of this region produced an average 1974 cost of $300 per capita for expansion of piping networks and pumping facilities. Service piping and metering increases this cost by $100 per capita.

In the Metropolitan Utilities District and Council Bluffs systems, pipelines 24-inch and larger and pumping stations are designed to differentiate costs for the alternative growth concepts. A reduced per capita cost of $300 is used for piping less than 24-inch in diameter and service

INSTALLED PIPELINE CAPITAL COST

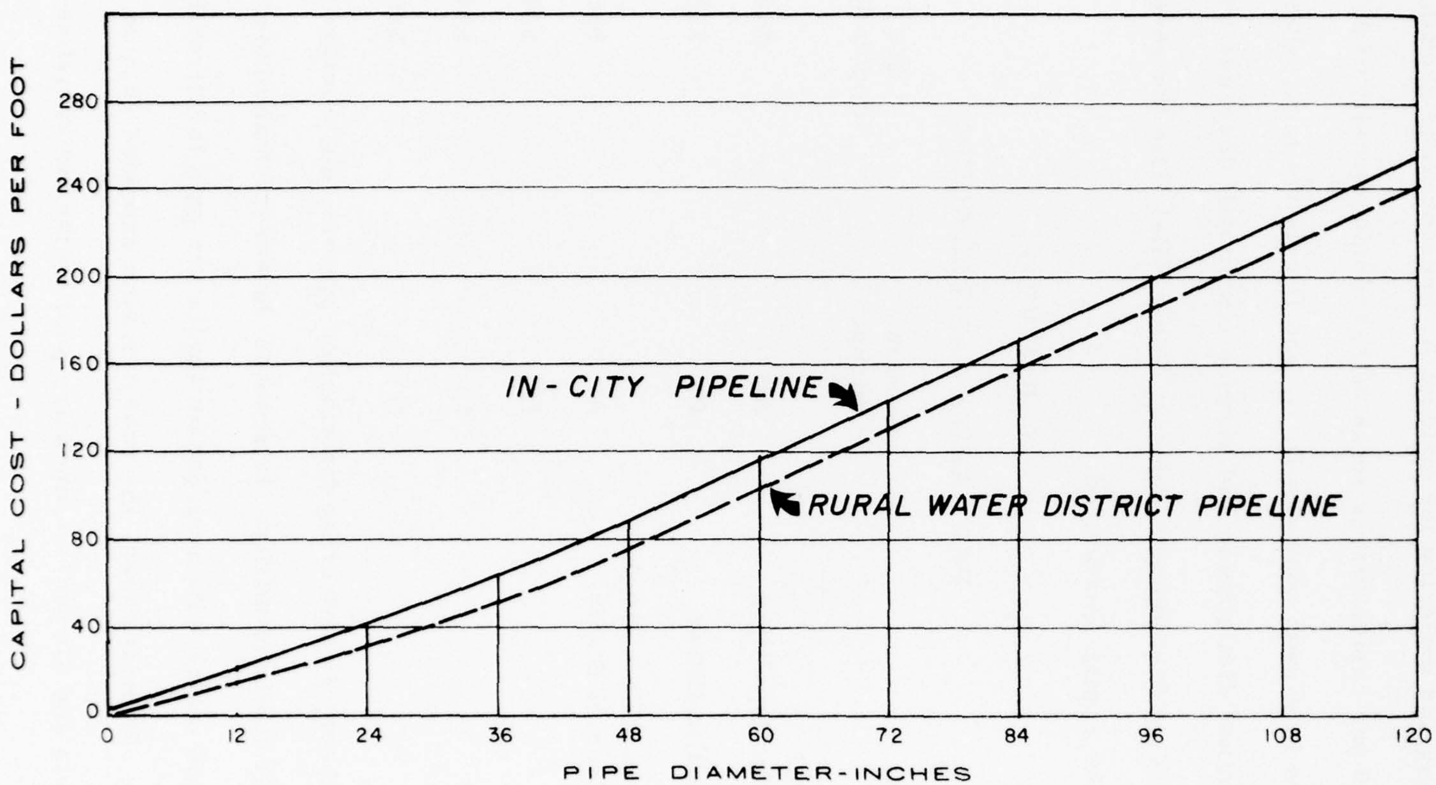


FIGURE VII - 9

piping and metering for concept A, present trend growth. The $300 per capita cost is adjusted based upon density of development in growth concepts B, C, and D relative to A, since length of minor distribution and service piping will decrease with increasing development density. Table VII-1 lists the several per capita capital costs used.

TABLE VII-1

PER CAPITA CAPITAL COSTS

Area	Growth Concept	$Per Capita Population Increase
Rural Municipalities	All	$400
Satellite Cities	B	$280
Metropolitan Omaha-Council Bluffs	A	$300
	B	$245
	C	$240
	D	$295

Methods of recovering distribution system construction costs vary from utility to utility. In general, however, transmission and distribution mains within corporate limits are paid for directly by the utility. In most cases, the cost of mains extended outside of corporate limits and all service lines are paid by the individual served. In

addition, a tapping fee - $90 by Council Bluffs - $38 and up by MUD may be charged by the utility. Meter costs are often born by the utility in smaller municipalities while MUD customers are required to purchase the meter. Responsibility for maintenance of meters and mains is usually assumed by the utility. Thus, the portion of per capita costs paid directly, indirectly, or in the form of monthly charges by an individual user is dependent upon location of the user both with respect to utility providing service and to proximity of existing services of the utility.

OPERATION AND MAINTENANCE COST METHODOLOGY

Available reports and records of utilities within the study area were examined and cost curves generated for the various sizes and types of facilities. As with capital costs, a substantial economy of scale is indicated for treatment and pumping facilities.

Treatment Plants

Operation and maintenance cost for treatment plants is a complete function of labor, chemical, power, sludge handling, general maintenance, administrative, and other costs. Curves in Figures VII-10 and VII-11 are for O & M costs other than chemical and sludge handling, and sludge handling respectively. Table VII-2 compares costs used for various treatment plants existing and proposed in the study area.

TREATMENT PLANT OPERATION AND MAINTENANCE COSTS
(Excluding Sludge Handling and Chemicals)

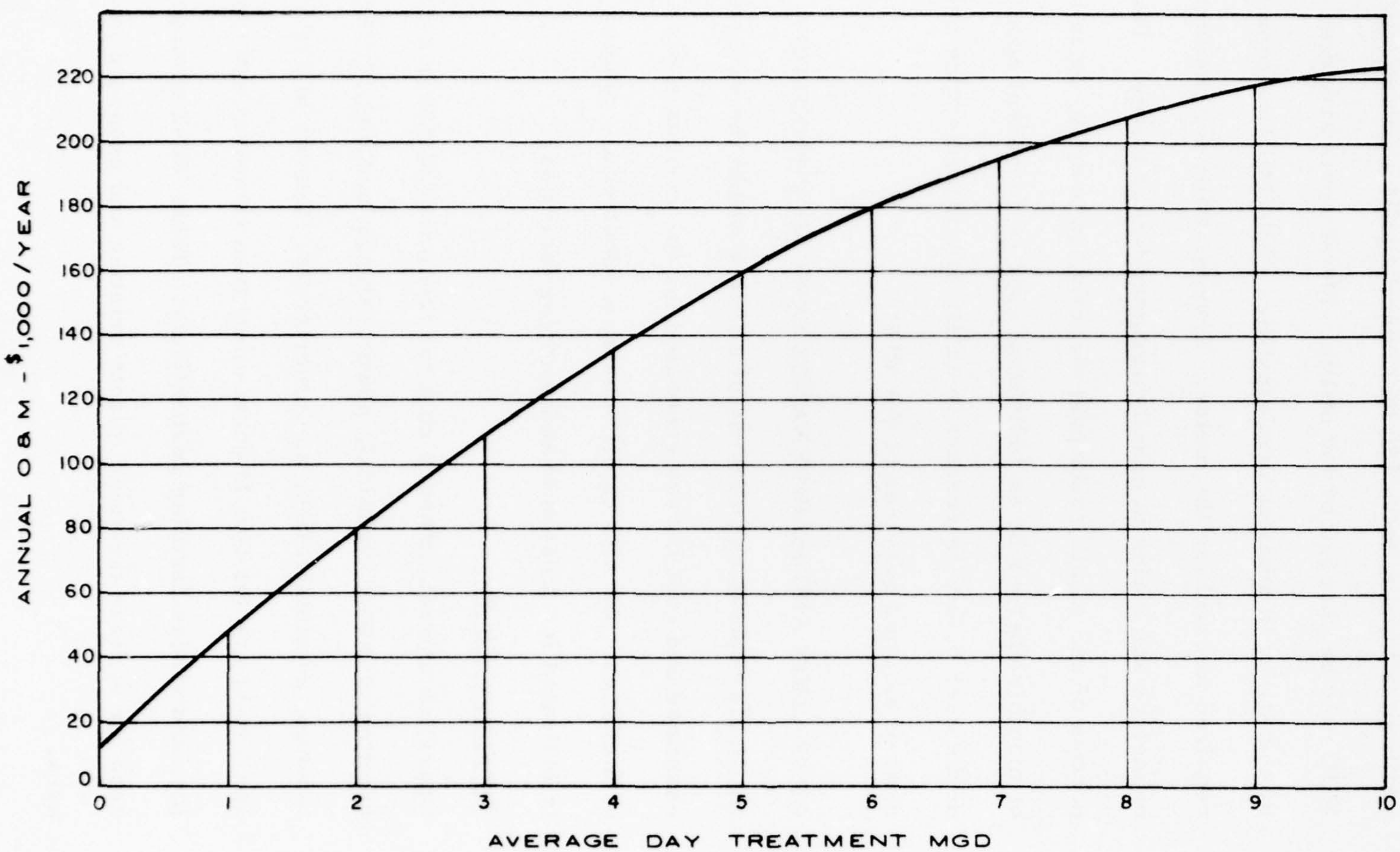


FIGURE VII - 10

WATER TREATMENT SLUDGE HANDLING
O & M COST

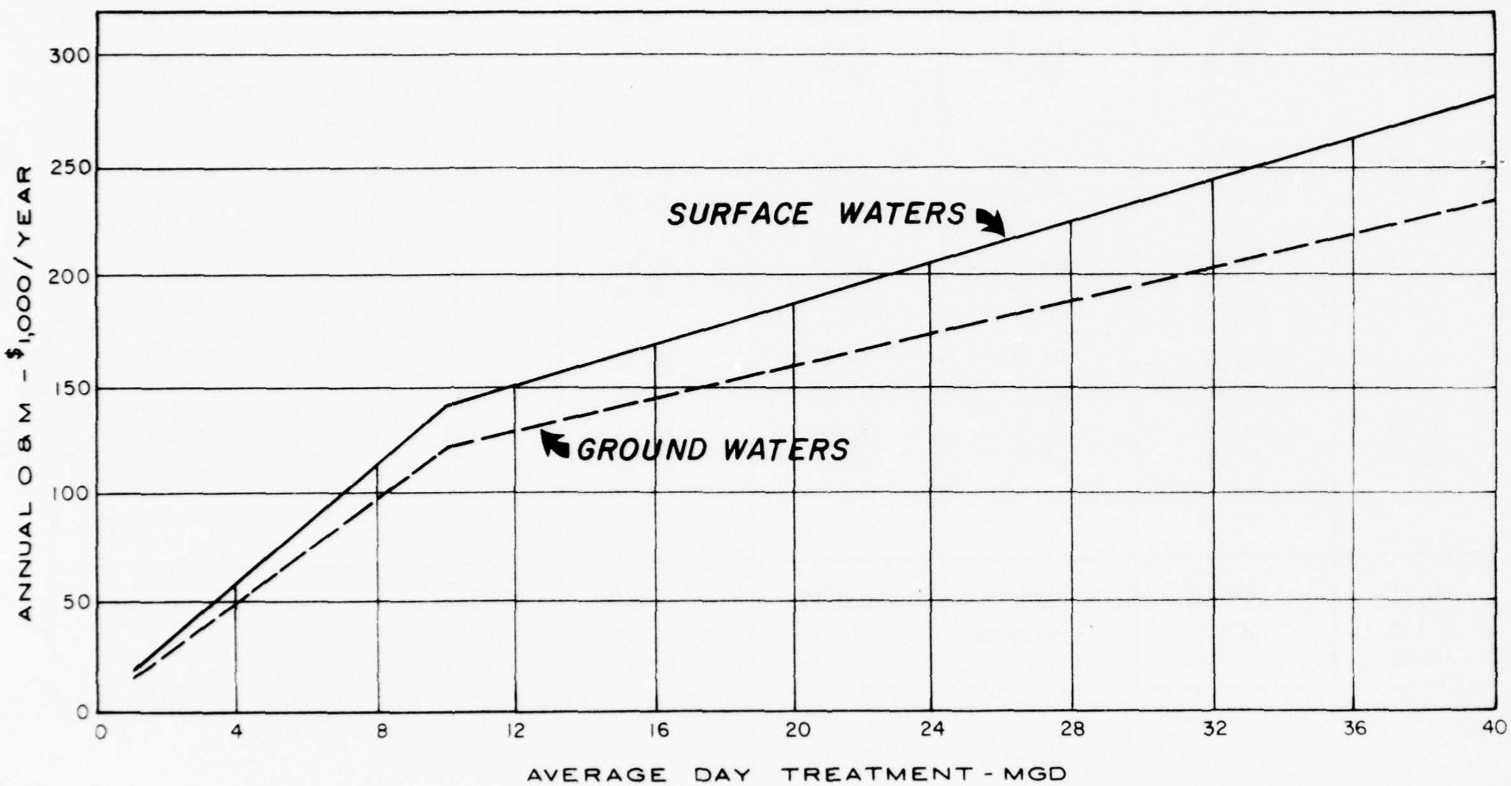


FIGURE VII - 11

TABLE VII-2

OPERATION AND MAINTENANCE COST COMPARISON

Treatment Facility	Average Treatment (MGD)	Chemical Cost ($/MG)	Power & Fuel ($/MG)	Sludge Handling ($/MG)	Other O & M ($/MG)	Total O & M ($/MG)
M.U.D.						
Florence						
existing	50	18.35	18.27	18.07	62.00	116.69
expanded	100	18.35	15.86	15.56	37.18	86.95
Platte South	30	13.02	16.42	17.83	37.18	84.45
Platte West	50	13.02	12.47	14.80	37.18	77.47
Missouri South						
surface	50	18.35	16.92	18.07	37.18	90.52
ground	50	24.50	16.92	14.80	37.18	93.40
Council Bluffs						
existing	8	35.00	25.00	38.64	53.70	152.34
expanded	10	35.00	18.30	38.19	37.20	128.69
Plants <20 MGD Capacity						
Missouri Valley						
ground	0.5	42.00	45.00	63.03	47.70	193.73
	10	42.00	20.00	33.01	38.40	132.41
surface	0.5	35.00	45.00	72.03	47.70	199.73
	10	35.00	20.00	38.19	38.40	131.59
Platte Valley	0.5	20.00	45.00	63.03	47.70	172.73
	10	20.00	20.00	33.01	38.40	111.41
Other	0.5	75.00	45.00	63.03	47.70	227.73
	10	75.00	20.00	33.01	38.40	166.41

Booster Pumping Stations

Figure VII-12 shows booster pumping station annual O & M cost for stations of less than 8 mgd capacity. Above an 8 mgd pumping capacity, $18 per mgd pumped is used.

Storage Facilities

Storage facility operation and maintenance costs are minimal compared to other system costs as indicated by Figure VII-13.

Pipelines

A yearly cost of 1.5 percent of capital is used for repair and replacement of pipelines and appurtenances.

Per Capita Costs

As with capital costs, a per capita basis is used for a portion of municipal water distribution and supply operation and maintenance costs. Table VII -3 lists yearly per capita costs based upon the entire population served. The per capita cost is adjusted based upon new growth density and proportion of new growth to reflect differences in alternative growth concepts.

BOOSTER STATION
O & M COST

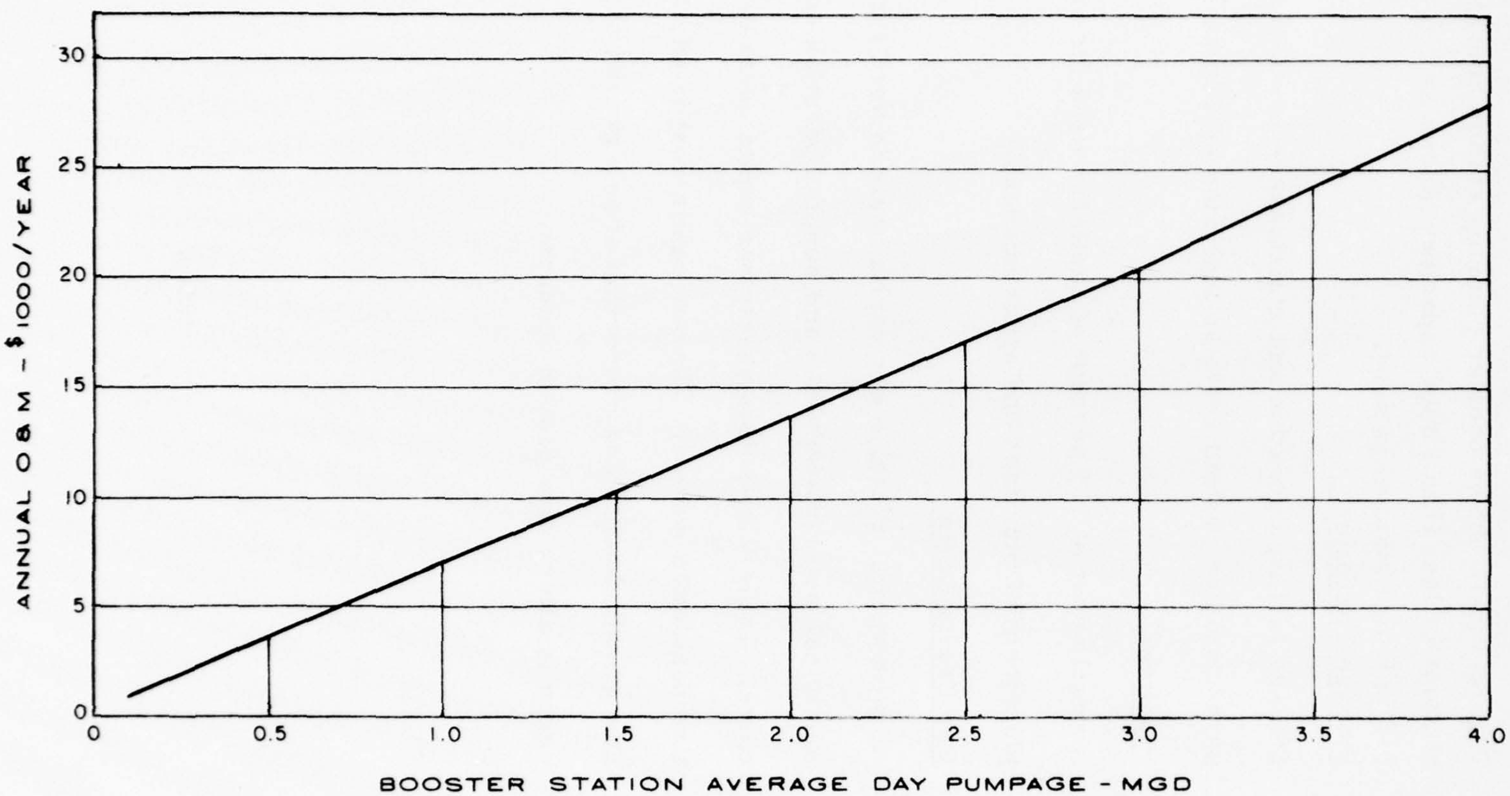


FIGURE VII - 12

STORAGE FACILITY
O & M COST

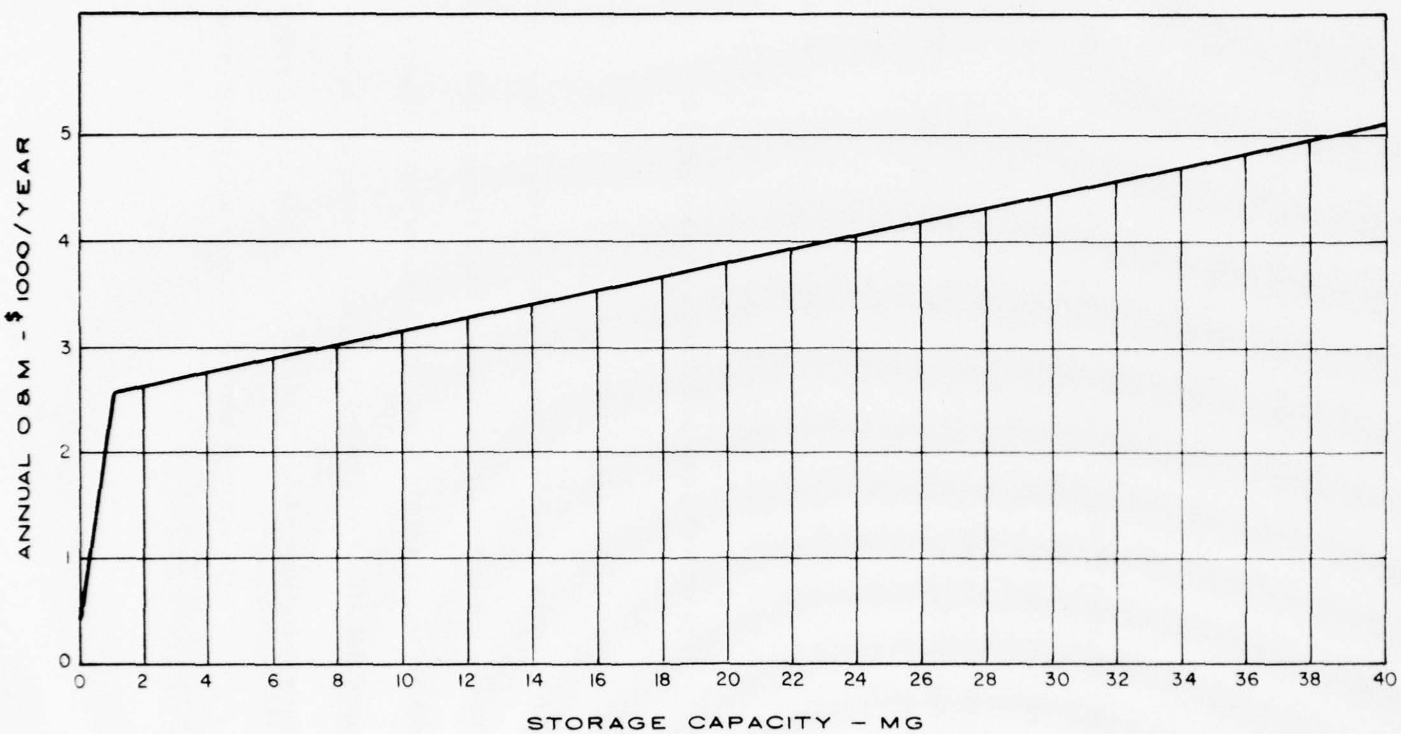


FIGURE VII - 13

TABLE VII-3

PER CAPITA ANNUAL OPERATION AND MAINTENANCE COSTS

Area	Growth Concept	$Per Capita Total Population Per Year
Rural Municipalities	All	$4.00
Satellite Cities	B	$2.80 - $3.15*
Metropolitan Omaha - Council Bluffs	A	$3.00
	B	$2.75
	C.	$2.65
	D	$2.95

*Dependent upon proportion of new growth.

PRESENT WORTH ANALYSIS

Facility costs are compared by determining the present worth of all operation and maintenance and capital costs to find the most cost-effective water supply plan. The present worth analysis also demonstrates the effect of alternative growth concepts on water supply costs. Complete listings of facilities and cost associated with each water supply plan, growth concept and alternative are found in Appendix 1, Section D.

Present Worth Methodology

Base year for the present worth analysis is 1975 with the study period ending in 2020. As previously mentioned, costs throughout the period are from curves generated based upon September, 1974 costs. Each facility type is assigned a life span as follows:

Treatment Plants	35 years
Booster Pumping Stations	25 years
Storage Facilities	50 years
Pipelines	75 years

For purposes of the present worth analysis, it is assumed that at the end of its respective life span, each facility has no salvage value and a replacement facility must be constructed at a cost equivalent to the 1974 basis initial construction cost. Salvage value in 2020 is computed for each facility using straight-line depreciation and is considered as a negative cost.

The present worth of each capital expenditure including replacement and salvage costs are computed using a single payment present worth factor. Annual operation and maintenance costs are computed for all years in which significant changes in the annual expenditure occur. A straight line gradient is assumed between these checkpoint years and operation and maintenance present worth is computed using

uniform series and gradient series present worth factors.

CONSIDERATIONS

Public vs. Private Softening

Average hardness of major raw water sources range from 210 mg/l (as $CaCO_3$) in Platte River well water to 250 mg/l in Missouri River water to 500 mg/l in Missouri River well water. Finished water hardness is in the range of 140 to 160 mg/l in Omaha Metropolitan Utilities District system and 110 to 130 mg/l in the Council Bluffs system. The following table sets general ranges for water quality with respect to hardness.

TABLE VII-4

WATER HARDNESS CLASSIFICATION

Hardness (mg/l as $CaCO_3$)	
0 - 75	Soft
75 - 150	Moderately hard
150 - 300	Hard
300 up	Very hard

Source: Sawyer and McCarty, Chemistry for Sanitary Engineers, McGraw-Hill, 1967.

According to this table, finished water in Council Bluffs would be considered moderately hard, suitable for most uses without additional softening. MUD treated water is on the borderline between a moderately hard and hard water, making additional softening beneficial in some instances and desirability of home softening a matter of personal preference. The principal objective of MUD treatment is hardness reduction producing a "stable" non-corrosive, non-depositing water.

For the purpose of evaluating economics of private and public softening, a Missouri River source with an average hardness of 250 mg/l treated to 100 mg/l in a public softening plant will be assumed. Private softening of the same raw water in a commercial cation exchange softener will be used for comparison. Only water to be heated (24% of residential usage) will be softened privately with the assumption that essentially all hardness is removed.

Based upon theoretical dosages and bulk chemical cost of 1.5¢/lb. lime (CaO) and 2.5¢/lb. soda ash (Na_2CO_3), chemical cost for removing 150 mg/l hardness in a public softening plant is $25.30 per million gallons. Cost of salt used in regeneration of a home softening unit using a retail price of 3.75¢/lb. and a theoretical regeneration rate of 0.45 lb. NaCl per kilogram hardness removed is $16.00

per million gallons treated. However only 24% of residential water usage will be softened resulting in a chemical cost of \$3.85 per million gallons used. Additional operation and maintenance costs for either means of softening are comparatively minor with the exception of lime sludge disposal which would cost about \$13.05 per million gallons of water treated.

Assuming 20 percent of a treatment plant cost can be attributed to softening, capital cost of public softening is \$86,250 per mgd capacity plus \$32,000 per mgd capacity for sludge handling facilities with a 25 percent contingency included. A commercial water softening unit sized for an average family of 4 costs about \$500. Assuming an average daily usage of 500 gpd per family, capital cost for home softeners is \$1,000,000 per mgd used. At 7 percent interest rate with a home softener life of 10 years, and a treatment plant life of 35 years, amortized capital costs are \$390.10 per mgd for home softening and \$25.00 per mgd for public softening. Table VII-5 summarizes softening costs.

TABLE VII-5

PUBLIC VS. PRIVATE SOFTENING

	Public	Private
	($/mgd)	
Amortized Capital Cost		
Home Softening Unit		390.10
Softening Plant	18.20	
Sludge Handling Facilities	6.80	
Subtotal	25.00	390.10
Operational Cost		
Chemical	25.30	3.85
Sludge Disposal	13.05	
Subtotal	38.35	3.85
Total	63.35	393.95

Disposal of spent regenerate brine solution is not included in private softening costs. Brine treatment cost would be very significant if total and dissolved solids reduction were required. Other variables and considerations affecting the preceding analysis such as water hardness and industrial water consumption will not significantly affect the substantial economic advantage of public softening.

Ground vs. Surface Raw Water Source

Water treatment facilities located in the plain of the Missouri River have the option of using the Missouri River as a raw water source or tapping generally abundant ground water supplies in aquifers underlying the valley. Several factors, including cost, dictate which source is to be developed. Proximity of upstream wastewater discharges is a consideration in use of a surface water supply. Availability and cost of land required for well field development also warrants inspection.

Non-metropolitan Treatment Facilities considered by this study which have the option of either ground or surface sources are located near Mondamin (Plan II), Blair (all Plans), Plattsmouth (Plans I and II), and Pacific Junction (Plans I and II). Maximum capacity of these plants range from 3.6 mgd to 28 mgd. Figures VII-14 through VII-16 compare initial construction cost, annual operation and maintenance costs, and present worth of capital and operation and maintenance costs for ground and surface water treatment facilities. Annual operation and maintenance costs are based upon average treatment at one-half of maximum plant capacity. Present worth comparisons use a 7 percent interest rate,

TREATMENT AND SLUDGE HANDLING FACILITIES
CAPITAL COST

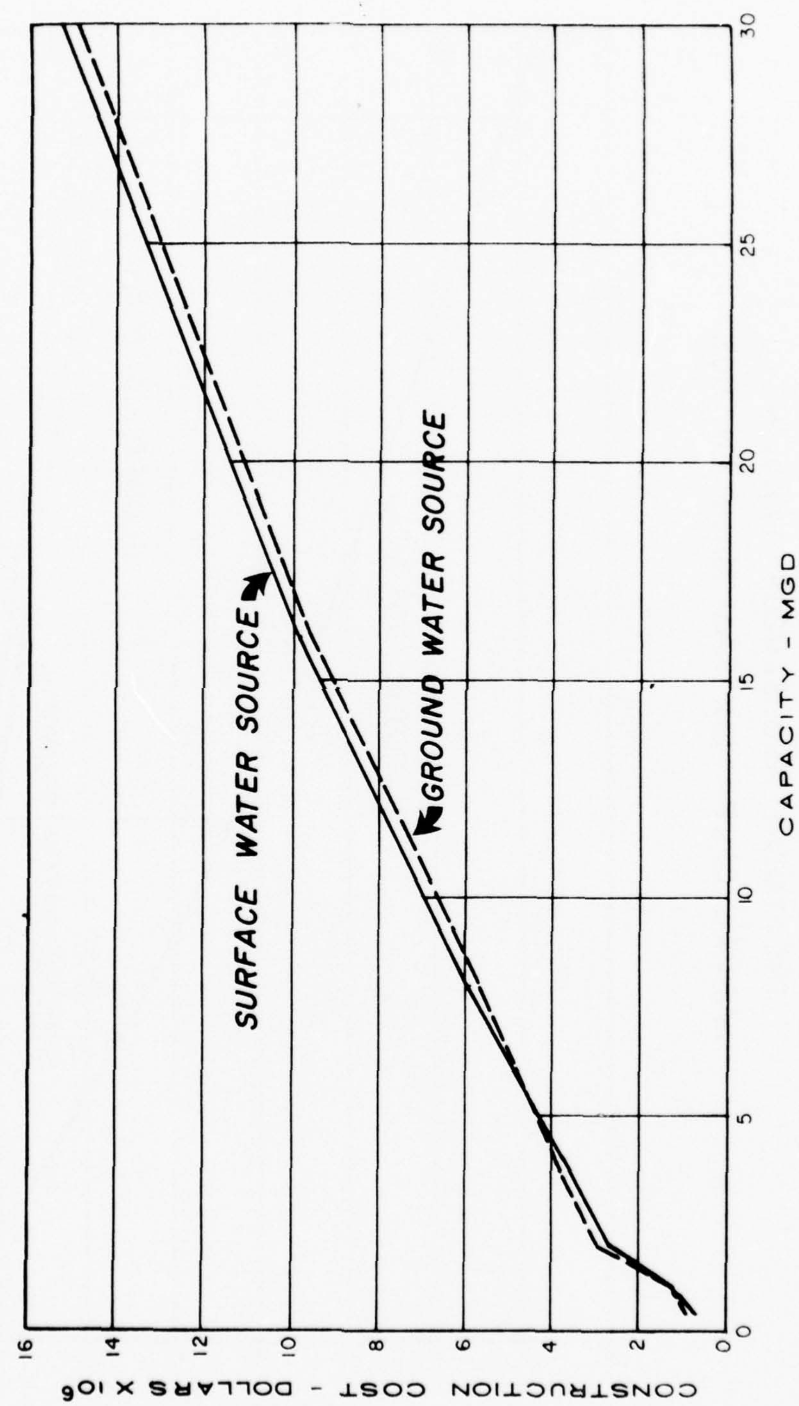


FIGURE VII - 14

TREATMENT AND SLUDGE HANDLING
ANNUAL OPERATION AND MAINTENANCE

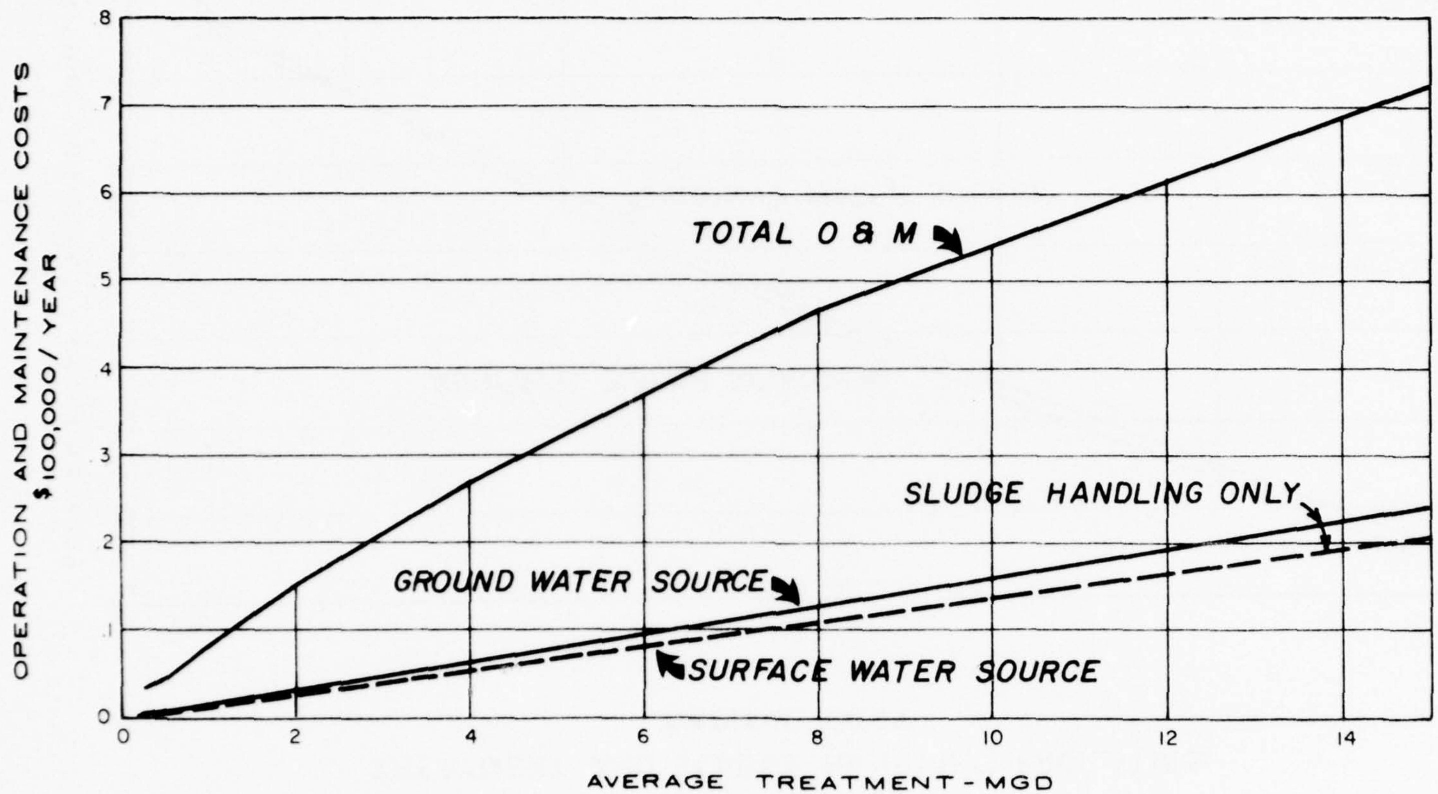


FIGURE VII - 15

PRESENT WORTH COMPARISON

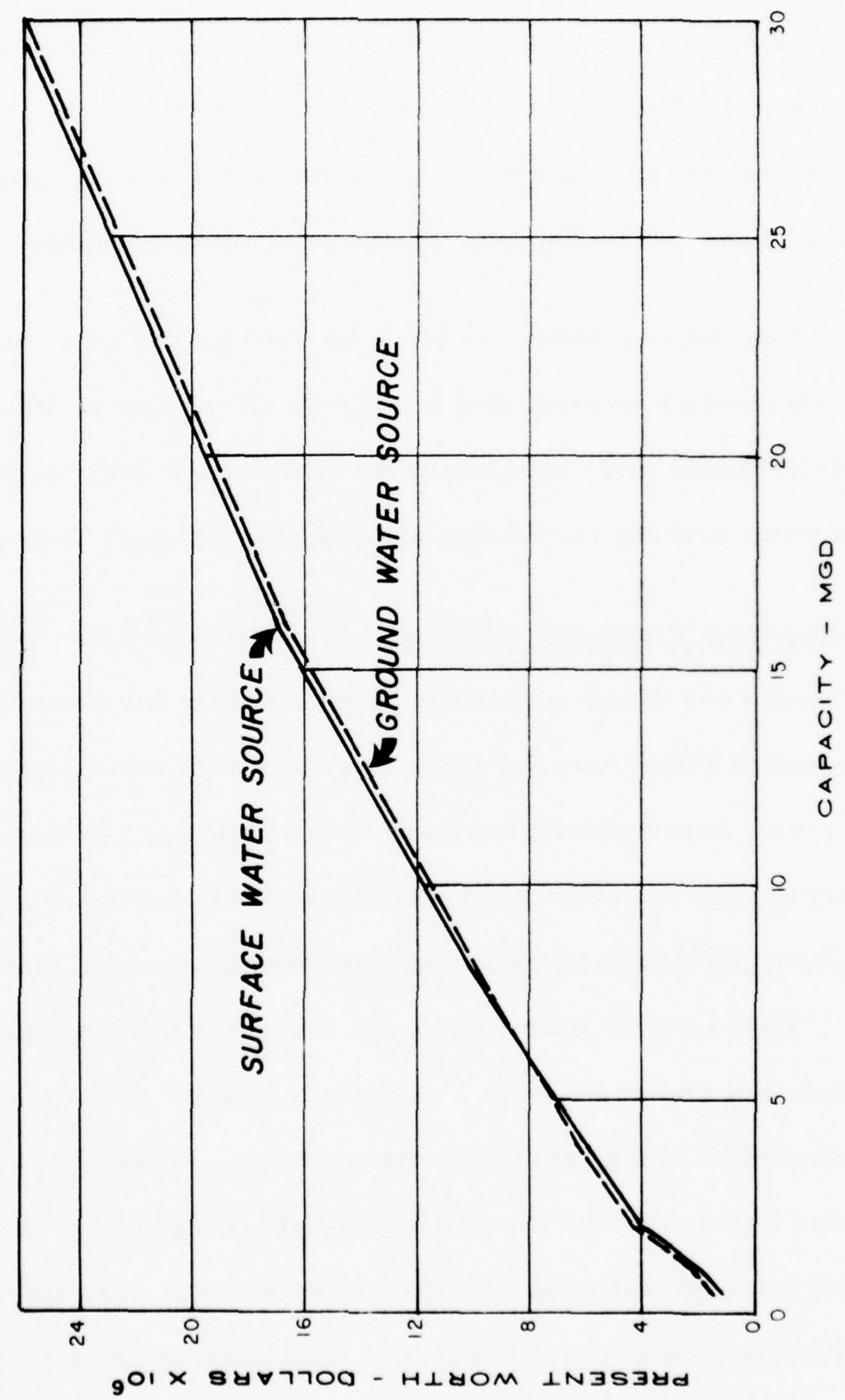


FIGURE VII - 16

construction in 1975 and operation at one-half of maximum capacity from 1975 to 2020. Costs are based upon the previously presented cost curves with a 25 percent contingency for capital and a 10 percent contingency for operation and maintenance.

Cost differences between use of surface and ground water sources are minimal as demonstrated in Figures VII-14 through VII-16. Considerations other than treatment economies therefore dictate raw water sources for the non-metropolitan Missouri River plants.

Metropolitan Treatment Facilities. The Missouri River South Plant in Plans I and III and expansions of the Florence and Council Bluffs Treatment Plants have the option of using either surface or ground sources. Cost tradeoffs for these larger facilities are increased chemical cost for ground water sources versus increased sludge handling capital and operation and maintenance cost for surface water. Figure VII-17 shows the annual savings of using surface water rather than ground water as a raw water source. From a break-even point of 10 mgd average daily treatment, savings increase at a rate of $1100 per year per additional mgd average daily treatment. Costs are deprived from cost curves presented in this report with a 10 percent chemical and operation and maintenance contingency

ANNUAL SAVINGS SURFACE VS. GROUND WATER SOURCE
METROPOLITAN AREA

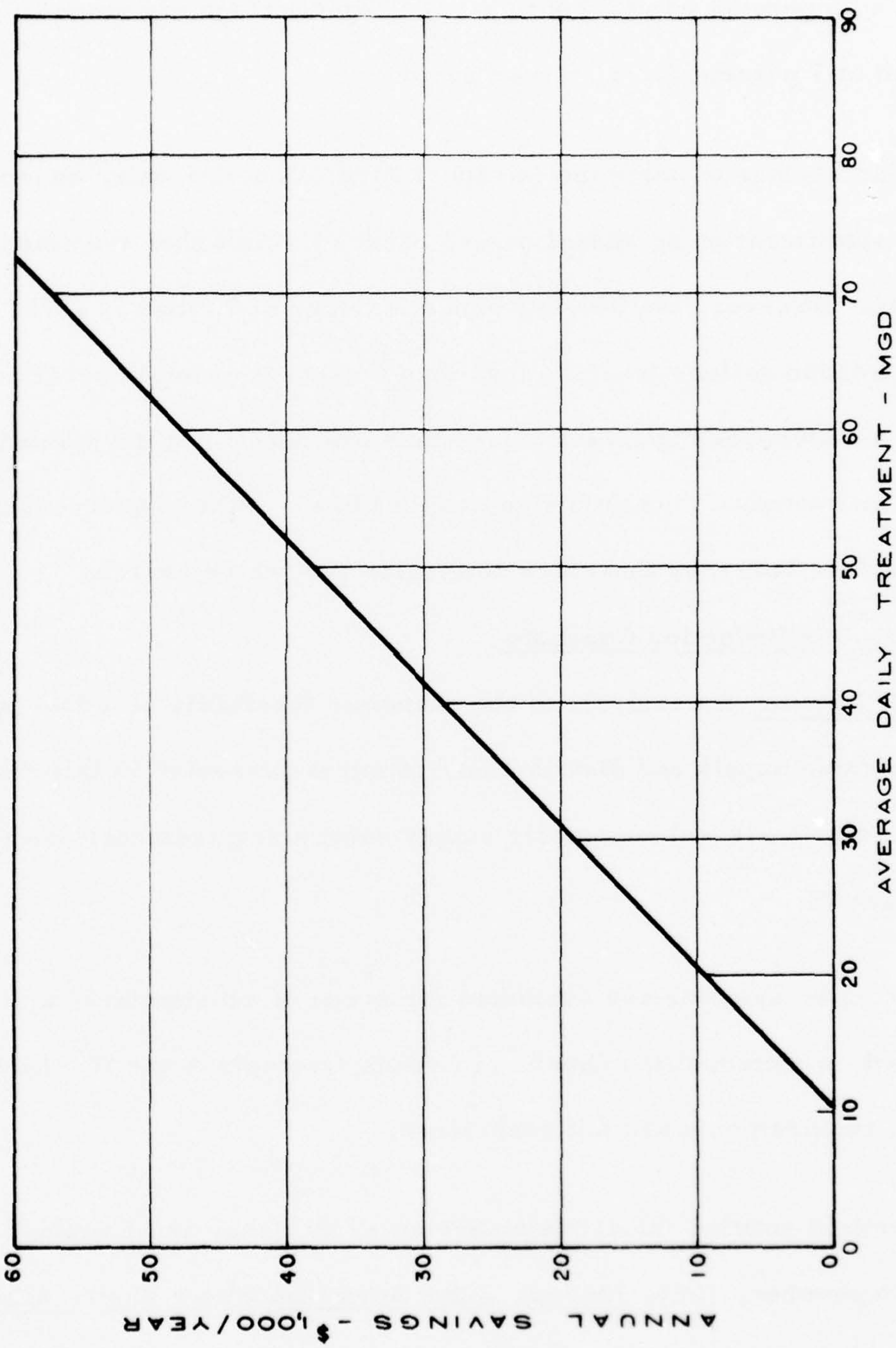


FIGURE VII - 17

and a 25 percent capital contingency. Capital costs are amortized at 7 percent for a 35 year period.

Dollar savings of using the Missouri River as a raw water source are significant on an annual basis, especially at higher treatment rates. However, the \$57,500 annual savings at 70 mgd is \$2.25 per million gallons treated, less than 3 percent of total operation and maintenance expense and less than one percent of the operation and maintenance plus amortized capital total. Other non-economic considerations may therefore determine raw water source.

Water Use Reduction Concepts

Dual System. An analysis of the economic feasibility of a dual potable-nonpotable supply and distribution system is presented in this section. Design criteria and nonpotable supply source requirements are given in Section VI.

Dual water systems are evaluated for areas of substantial new growth in metropolitan Omaha in Growth Concepts A and C. Industrial requirements are not considered.

An article entitled "Dual Water Systems" by Haney and Hamann in the September, 1965, Journal of the American Water Works Association provides a general guideline for dual system cost analysis.

FIGURE VII - 13

Basis for computation of dual water system capital, and operation and maintenance costs follow. Storage and transmission main expenses are assumed to remain unchanged. Booster pumping station capital costs are increased 20 percent with power costs remaining unchanged and other O&M costs increased by 20 percent. Expenditures for distribution mains are increased by 40 percent. The cost of service lines and meters are doubled. In-house plumbing costs are not included in the analysis but should be nearly equal for conventional and dual systems in new construction. Supply and treatment costs are evaluated separately for each source considered.

Supply and treatment cost reduction for the conventional system are based upon reduction in plant capacity equal to maximum day nonpotable system requirements and an O&M cost of $110 per mg treated. Nonpotable ground and surface water supplies are sized to supply maximum day nonpotable requirements. Costs of stormwater and wastewater treatment are derived from the Regional Wastewater Management Study Phase 1 and are taken as the cost to provide a nonpotable water quality equal to level 3 wastewater or level 2 stormwater treatment. In other words, cost of using a lower quality wastewater is that involved in providing a facility

to treat to the higher level plus the difference in operation and maintenance costs. Treatment and supply costs for nonpotable use of wastewater treated to meet level 3 or stormwater treated to meet level 2 effluent requirements are assumed to be zero.

Treatment costs for nonpotable supply sources are summarized in Table VII-6.

TABLE VII-6

TREATMENT OPERATION AND MAINTENANCE COST - CONVENTIONAL VS. DUAL SYSTEM

	O & M ($/mg)	Dual system savings ($/mg)
Conventional	$110[1]	$ --
Nonpotable		
Ground water	$ 12[1]	$ 98
Surface water	$ 54[1]	$ 56
Stormwater		
Level 1 to Level 2	$ 23[2]	$ 87
Level 2	$ 0[2]	$110
Wastewater		
Level 1 to Level 3	$130[2]	$-20
Level 2 to Level 3	$ 62[2]	$ 48
Level 3	$ 0[2]	$110

Source:
[1]HDR, [2]Derived from Regional Wastewater Management Study, Phase 1, Havens and Emerson, Ltd.

A comparison of capital costs for conventional and dual supply, treatment, and distribution systems is presented in Table VII-7.

TABLE VII-7
CAPITAL COST COMPARISON-
DUAL VS. CONVENTIONAL SYSTEM [1]

SOURCE		CONCEPT IA			CONCEPT IC		
		Capital Cost increase for a Dual System	Capital Cost decrease for a Dual System	Net Capital Cost Increase	Capital Cost increase for a Dual System	Capital Cost decrease for a Dual System	Net Capital Cost Increase
	Service Line & Meter	32.78			18.87		
	Distribution	26.22			15.10		
	Transmission	81.07			64.91		
	Storage	0.00			0.00		
	Pumping	1.60			1.38		
	Sub Total	141.67			100.26		
Surface	Treatment		25.11			11.03	
	Total			116.56			89.23
Groundwater							
	Treatment		35.50			15.60	
	Total			106.17			84.66
Level 1 Stormwater							
	Treatment		0.98		1.53		
	Total			140.69			101.79
Level 2 Stormwater							
	Treatment		37.08			16.29	
	Total			104.59			83.97
Level 1 Wastewater							
	Treatment		26.91			11.25	
	Total			114.76			89.01
Level 2 Wastewater							
	Treatment		32.48			14.05	
	Total			109.19			86.21
Level 3 Wastewater							
	Treatment		37.08			16.29	
	Total			104.59			83.97

[1] Costs in $ 1,000,000

Source: HDR, and Regional Wastewater Management Study, Phase 1, Havens and Emerson, Ltd.

Costs are for supplying 2020 nonpotable water requirements shown in Table VI-11.

The additional cost of a dual water system in 2020 on an annual basis is given in Table VII-7. Capital costs are amortized at an interest rate of 7 percent with facility lives as given previously in this section of the report.

As shown in Table VII-8, the additional cost to provide dual potable and nonpotable treatment and distribution systems is substantial amounting to a minimum of $980 per mg in Concept A and $1680 per mg in Concept C. Since assumptions made favored a dual system with resultant costs much higher than a conventional system, further refinement and expansion of the dual system concept does not appear warranted.

Other Concepts, namely, a 50% price increase and use of water conserving fixtures and appliances are examined in this section with respect to cost reduction potential.

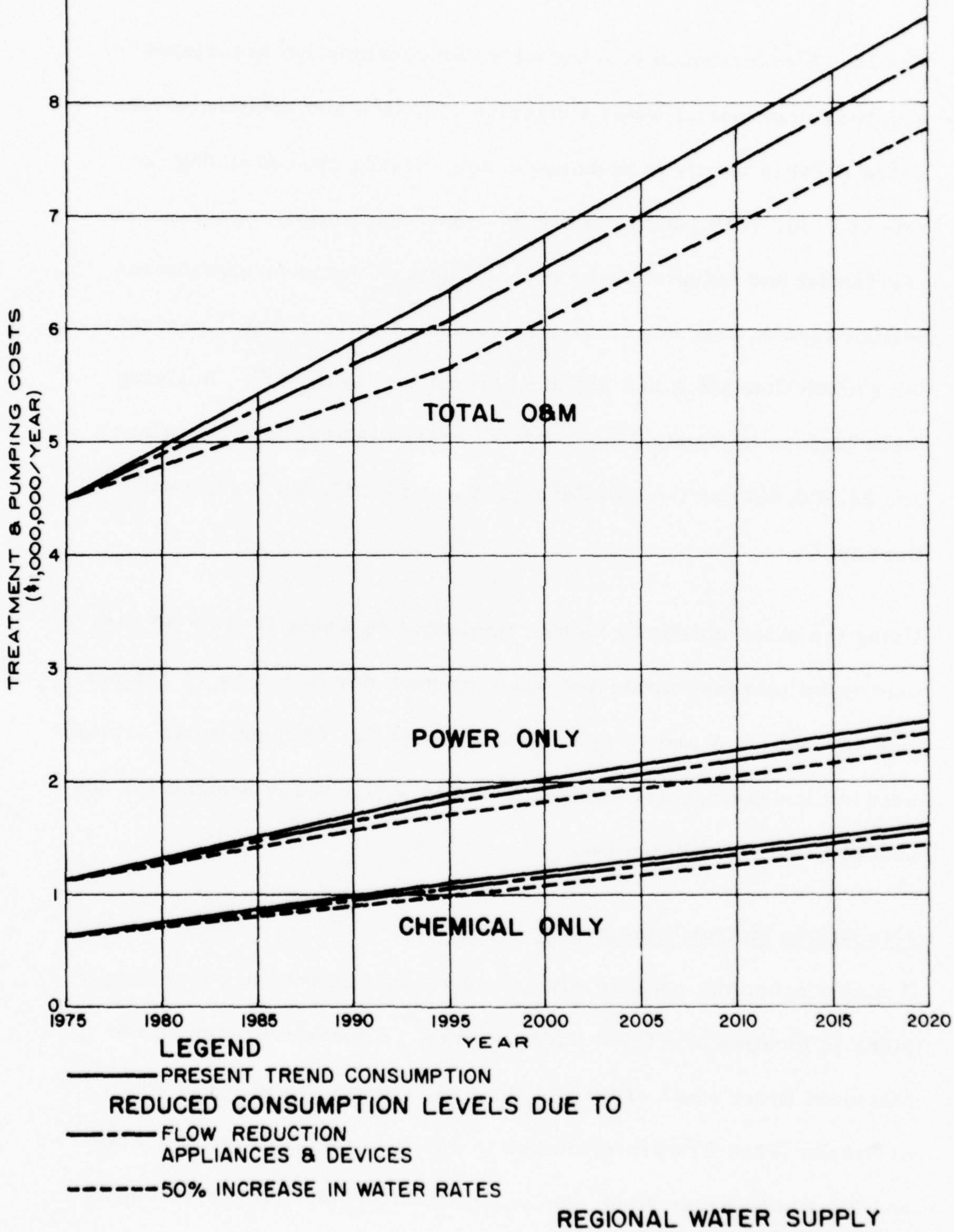
Annual operation and maintenance savings due to reduced water consumption are proportional to the reduction in average daily usage. A majority of savings accrue from reduced treatment and pumping costs. For the two concepts under consideration, little or no reduction in

TABLE VII-8
ANNUAL COST COMPARISON-
DUAL VS. CONVENTIONAL SYSTEM

Concept	Nonpotable Supply Source	Amortized Capital Cost Increase 1	Distribution System O & M Cost Increase 2	Treatment O & M Cost Decrease 3	Net Annual Cost Increase (1+2-3)
		$ 1,000/YEAR			
IA	Surface	7978	1417	755	8640
	Ground	7175	1417	431	8551
	Stormwater				
	Level 1	9841	1417	670	10,588
	Level 2	7053	1417	847	7623
	Wastewater				
	Level 1	7839	1417	- 154	9410
	Level 2	7408	1417	370	8455
	Level 3	7053	1417	847	7623
IC	Surface	6189	1003	371	6821
	Ground	5836	1003	212	6627
	Stormwater				
	Level 1	7159	1003	329	7833
	Level 2	5783	1003	416	6370
	Wastewater				
	Level 1	6173	1003	- 77	7253
	Level 2	5956	1003	182	6777
	Level 3	5783	1003	416	6370

pipeline and distribution facility operation and maintenance costs or treatment and pumping O & M unit costs is expected. Annual savings in total O & M, power, and chemical due to treatment and pumping at reduced quantities of water are depicted graphically in Figure VII-18. Savings indicated are for metropolitan Omaha-Council Bluffs, Scheme IIA. For other Growth Concepts, the reduction in annual expenditures would be about the same on a percentage basis, about 4 percent for water conserving fixtures and 11 percent for a 50 percent price increase.

While operation and maintenance costs are approximately proportional to average daily water requirements, capital expenditures for supply and distribution facilities are more nearly proportional to peak day and peak hour demands. Therefore, the effect of water reduction concepts on peaking factors must be evaluated to determine capital savings. It is assumed that the reduction in peak day demand is a valid indicator of reduced treatment plant, pumping, storage, and transmission main requirements. Distribution and service main sizes and hence costs should not be affected by the degree of peak demand reduction evaluated since fire flow requirements and system reliability factors are determining factors.



REGIONAL WATER SUPPLY

EFFECT OF REDUCED WATER CONSUMPTION

U.S. ARMY DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE VII-18

The 10.4% reduction in residential water consumption associated with maximum use of water conserving fixtures and appliances (see Table IV-5) is totally in in-house usage. Based upon peak day facrots of 1.30, 7.15, and 1.95 for in-house residential, out-of-house residential and industrial-commercial usages respectively; metropolitan system peak day factors are reduced by less than 2 percent for growth Concept A and about 3 percent for Concept C. Applying these factors to Supply Plan II costs, present worth capital savings are $2,900,000 for Growth Concept A and $4,200,000 for Growth Concept C.

Using the price elasticity factors presented in Table IV-1, a 50 percent price increase would decrease the peak day factor by 17 1/2 percent in Concept A and 16 percent in Concept C. Present worth capital expenditure savings are estimated as $25,600,000 for Scheme IIA and $22,200,000 for Scheme IIC.

Alternative Metropolitan Supply Sites

A major economic consideration in metropolitan Omaha water supply plans is location of a third major source. Alternative sites on the Missouri River south of Omaha (Plan C) and the Platte River west of Omaha (Plan B) were evaluated in detail in the MUD Master Plan and the Platte River West site was recommended. Increased supply

and treatment capacity in the area of MUD's Florence treatment plant to meet water needs to 2020 was a third alternative (Plan A) evaluated in the Master Plan. Preliminary investigations indicated this plan to be the most expensive due to the additional length of large diameter transmission main required to supply demand centers in western and southwestern Omaha from the plant in northeastern Omaha.

Missouri South vs. Florence Site. Figure VII-19 compares the routes and sizes of major transmission mains from an expended Florence Plant and a new Missouri South Plant. Based upon cost curves generated for this report, transmission mains would cost $13,660,000 more for the site north of Omaha than the site south of Omaha in Growth Concept A and $8,750,000 in Growth Concept C. Other costs would be comparable for the two sites. A major new booster pumping station would be required in either case.

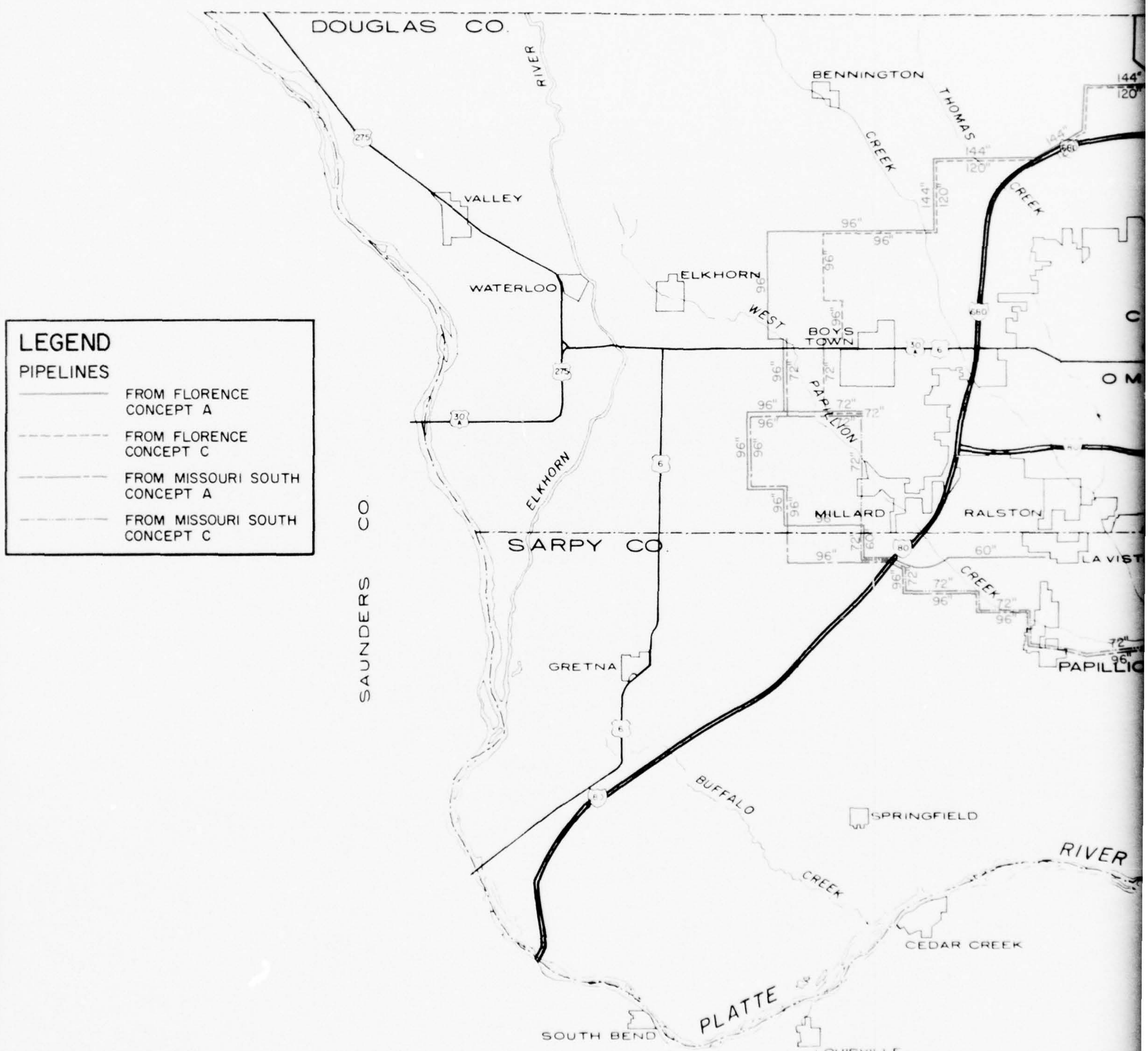
The advantage of initial pumping from a higher elevation at the Florence site would be offset by additional head loss in the longer transmission main. The indicated savings in transmission main capital cost make development of a Missouri South supply source and treatment plant economically preferable to expansion in the vicinity of the Florence Plant.

Platte West vs. Missouri South Site

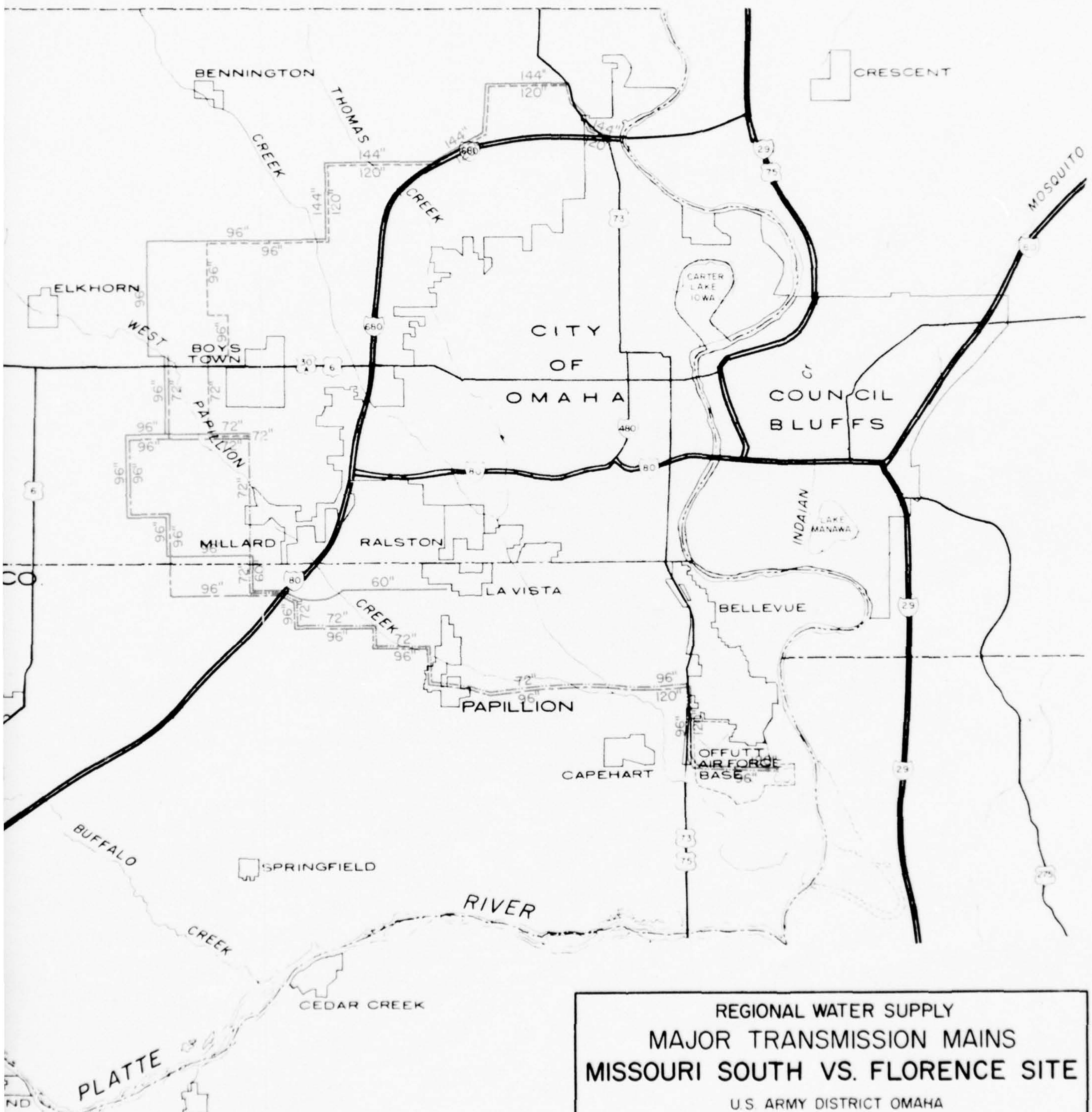
Source reliability problems at the Platte River site mentioned by the Master Plan and further considered in this report in light of preliminary findings of the Platte Level "B" Study warrant detailed consideration of economic benefits accrued by metropolitan Omaha in development of the Platte River West site.

Of major economic concern are increased chemical, primary pumping, and secondary pumping costs associated with the Missouri River South site. Chemical costs reflect the generally more desirable quality of Platte Valley ground water versus either Missouri River water or Missouri River Valley ground water. A higher treatment plant ground elevation and more direct route to developing usage centers decreased the primary and secondary pumping requirements. Power and fuel cost for pumping is reduced and less booster station capacity is required. An additional economic consideration when evaluating Missouri River water as a source is the reduced sludge handling capital and operation and maintenance cost of using a ground water.

Cost differentials between Missouri River South and Platte River West source locations are summarized on an annual basis in Table VII-9. Capital costs are amortized at an interest rate of 7 percent.



LEGEND
PIPELINES
FROM FLORENCE CONCEPT A
FROM FLORENCE CONCEPT C
FROM MISSOURI SOUTH CONCEPT A
FROM MISSOURI SOUTH CONCEPT C
DOUGLAS CO.
SARPY CO.
SAUNDERS CO.
BENNINGTON
VALLEY
WATERLOO
ELKHORN
BOYS TOWN
MILLARD
RALSTON
LA VISTA
PAPILLION
GRETNA
SPRINGFIELD
CEDAR CREEK
SOUTH BEND
LOUISVILLE
PLATTE
RIVER
ELKHORN
WEST PAPILLION
THOMAS CREEK
BUFFALO CREEK
CREEK
OM
144"
120"
96"
72"
60"



REGIONAL WATER SUPPLY
MAJOR TRANSMISSION MAINS
MISSOURI SOUTH VS. FLORENCE SITE
U.S. ARMY DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

FIGURE VII-19

2

TABLE VII - 9

ANNUAL COST COMPARISON - MISSOURI SOUTH VS. PLATTE WEST SOURCE

($1,000/YEAR)

Con-cept	YEAR	AVERAGE TREATMENT (mgd)	ANNUAL OPERATION AND MAINTENANCE TREATMENT AND PUMPING				AMORTIZED CAPITAL		TOTAL ANNUAL SAVINGS	SAVINGS (¢/1000 gal)
			CHEMICAL	POWER & FUEL	SLUDGE HANDLING	OTHER	SLUDGE HANDLING	PUMPING		
Missouri River Valley Ground Water										
A	1995	41.35	173.3	168.4		10.1		271.4	623.2	4.1
	2020	73.73	308.9	326.4		20.7		271.4	927.4	3.4
B	1995	37.42	156.8	124.9		6.4		61.7	349.8	2.6
	2020	55.74	232.1	144.4		5.4		61.7	443.6	2.2
C	1995	35.61	149.2	107.5		5.0		111.0	372.7	2.9
	2020	60.17	252.1	174.8		7.7		111.0	545.6	2.5
D	1995	43.17	180.9	170.9		10.1		264.0	625.9	4.0
	2020	72.64	304.4	322.3		20.4		264.0	911.1	3.4
Missouri River Water										
A	1995	41.35	80.4	168.4	50.9	10.1	168.9	271.4	750.1	5.0
	2020	73.73	143.4	326.4	84.0	20.7	168.9	271.4	1014.8	3.8
B	1995	37.42	72.8	124.9	47.0	6.4	115.8	61.7	428.6	3.1
	2020	55.74	108.4	144.4	65.5	5.4	115.8	61.7	501.2	2.5
C	1995	35.61	69.3	107.5	45.1	5.0	130.3	111.0	468.2	3.6
	2020	60.17	117.1	174.8	70.1	7.7	130.3	111.0	611.0	2.8
D	1995	43.17	84.0	170.9	52.8	10.1	154.5	264.0	736.3	4.7
	2020	72.64	141.3	322.3	82.7	20.4	154.5	264.0	985.2	3.7

RESULTS

Complete results of operation and maintenance and capital cost computations are contained in Appendix 1, Section D. Also listed in Section D of the appendix are present worth summations for each Water Supply Scheme in metropolitan and non-metropolitan areas. Most alternative considerations that follow are on a present worth basis since this value offers the most valid comparison of capital, operation and maintenance, and staging benefits for each alternative.

Water Supply Schemes

Present worth values for operation and maintenance and capital expenditures for 16 Water Supply Schemes are tabulated in Tables VII-10 through VII-13. Total study area costs offer the most valid comparison of schemes since a substantial population shift from metropolitan to non-metropolitan area occurs in Concept B and metropolitan treatment plants supply non-metropolitan areas in Plans II and III.

Perhaps most surprising is the uniformity of costs with less than a 12 percent differential between the least costly scheme (IIC) and the most costly (IA2). Cost for a particular Growth Concept vary a maximum of 5.6 percent (IIA to IA2) and a maximum of 9.1 percent with a single Supply Plan (IC2 to IA2).

TABLE VII - 10

PRESENT WORTH COMPARISON OF ALTERNATIVE SUPPLY SCHEMES

($1,000,000)

SCHEME	IB I	IA I	IC I	ID I
NON METROPOLITAN				
Capital	99.60	82.02	82.02	82.02
O & M	29.34	24.76	24.76	24.76
Total	128.94	106.78	106.78	106.78
METROPOLITAN				
Capital	176.94	220.18	189.51	216.43
O & M	110.40	119.91	113.51	119.21
Total	287.35	340.09	303.02	335.64
STUDY AREA				
Capital	276.54	302.20	271.53	298.45
O & M	139.74	144.67	138.27	143.97
Total	416.28	446.87	409.80	442.42

TABLE VII - 11

PRESENT WORTH COMPARISON OF ALTERNATIVE SUPPLY SCHEMES

($1,000,000)

SCHEME	IB 2	IA 2	IC 2	ID 2
NON METROPOLITAN				
Capital	103.00	85.07	85.07	85.07
O & M	29.21	24.50	24.50	24.50
Total	132.21	109.57	109.57	109.57
METROPOLITAN				
Capital	177.32	220.00	189.92	216.03
O & M	110.69	120.32	113.86	119.62
Total	288.01	340.32	303.78	335.65
STUDY AREA				
Capital	280.32	305.07	274.99	301.10
O & M	139.90	144.82	138.36	144.12
Total	419.22	449.89	413.35	445.22

TABLE VII - 12

PRESENT WORTH COMPARISON OF ALTERNATIVE SUPPLY SCHEMES

($1,000,000)

SCHEME	II B	II A	II C	II D
NON METROPOLITAN				
Capital	90.23	74.97	74.97	74.97
O & M	26.24	22.52	22.52	22.52
Total	116.47	97.49	97.49	97.49
METROPOLITAN				
Capital	179.69	212.58	191.60	209.34
O & M	109.91	117.28	113.23	116.67
Total	289.60	329.86	304.83	326.01
STUDY AREA				
Capital	269.92	287.55	266.57	284.31
O & M	136.15	139.80	135.75	139.19
Total	406.07	427.35	402.32	423.50

TABLE VII - 13
PRESENT WORTH COMPARISON OF ALTERNATIVE SUPPLY SCHEMES
($1,000,000)

SCHEME	III B	III A	III C	III D
NON METROPOLITAN				
Capital	85.20	70.25	70.25	70.25
O & M	21.27	18.30	18.30	18.30
Total	106.47	88.55	88.55	88.55
METROPOLITAN				
Capital	185.51	225.21	198.04	223.59
O & M	115.16	123.26	117.16	122.92
Total	300.67	348.47	315.20	346.51
STUDY AREA				
Capital	270.71	295.46	268.29	293.84
O & M	136.43	141.56	135.46	141.22
Total	407.14	437.02	403.75	435.06

In all Water Supply Plans, costs increase according to Growth Concept in the order: C, B, D, A. Supply Plan ranking from least to most costly is II, III, IA1, IA2.

Alternatives

In Plan I, Alternatives of self-supply vs. supply from MUD to Springfield, and construction of new treatment plants treating Missouri River water vs. expansion of existing ground water supplied treatment plants at Pacific Junction (Glenwood) and Plattsmouth are evaluated.

The present worth of MUD treatment, pumping and pipeline to Springfield is $1,155,000 compared to $1,376,000 for a treatment plant serving only Springfield in Concept E (A, C, and D). The $221,000 differential increased to $660,000 in Concept B where Springfield increases in size as a satellite city. Springfield is assumed to be supplied by MUD in Plans II and III. Similar analyses for each Douglas-Sarpy County community would indicate the economics of MUD service over construction of new individual municipality treatment facilities. Present worth savings of $604,000 in Concept E, and $536,000 in Concept B resulting from expansion rather than replacement of the Pacific Junction treatment plant amount to only 6.1 (E) and 5.3 (B) percent reductions in treatment, sludge handling and distribution pipeline cost. Cost reductions at Plattsmouth are $2,282,500 (48%) in

Concept E and $2,827,000 (35%) in Concept B in favor of expansion of the existing treatment facility. As expected, the benefit of retaining the larger (3.0 mgd vs 0.72 mgd), newer (1973 vs 1965), treatment facility at Plattsmouth is much greater than that at Pacific Junction. A new treatment facility near Pacific Junction treatment Missouri River water to supply Mills County is assumed in Plan II since the increased capacity required would reduce economic benefits of expanding the existing facility.

Average Monthly Billings

As a means of comparing costs, average monthly residential water billings are computed by county in Washington, Harrison, Pottawattamie (excluding Council Bluffs), and Mills counties. Billings computed according to the methodology which follows are intended for comparative use. While billings which follow are indicative of actual billings should a supply plan be developed as described, design of the rate schedules necessary to compute actual billings is beyond the scope of this report.

In computation of average monthly billings, the present worth of facilities associated with municipalities (treatment, storage, pipeline and per capita) are amortized at 7 percent from 1975 to 2020.

These costs are reduced proportional to industrial demands. Rural pumping, storage, and pipelines are assumed to be constructed in 1985, therefore the 1985 present worth is amortized at 7 percent from 1985 to 2020. A hookup fee of $1000 per connection is assumed for rural users to help balance the inequity of construction costs between municipal and rural users. An annual amount needed for operation and debt retirement is thus calculated. Total 1995 county populations are divided by 1970 per capita per dwelling figures to compute customers served. The annual cost is then divided by the number of customers and 12 months per year to determine average monthly billing. Table VII-14 lists average monthly billings computed in this manner.

TABLE VII-14

AVERAGE MONTHLY WATER BILLING

County	Plan / Concept	I		II		III	
		E	B	E	B	E	B
Washington		22.95	13.95	20.00 23.23[1]	10.90	21.00	13.00
Harrison		22.85	18.50	24.75	19.75	24.75	19.85
Pottawattamie		26.60	26.60	25.25	25.25	25.25	25.25
Mills		28.55	19.05	26.10	19.00	31.50	20.40

[1] From Papio NRD Rural Water System Engineering Report, 1974. Average monthly billing for area served in alternate 4.

Nonmetropolitan Municipal Treatment

Water Supply Schemes discussed in detail in this report are based upon development of rural-urban water systems to serve nonmetropolitan residents. Table VII-15 compares the capital expenditures required by 2020 to construct treatment facilities supplying all area residents under the various Supply Plans versus service to residents of municipalities only. The municipal treatment facilities are assumed to be developed individually by each municipality to serve residents within corporate boundaries. Two levels of treatment are indicated: (1) treatment of water not meeting U.S.P.H.S. standards for iron and/or manganese to remove these constituents and to reduce hardness, and (2) treatment of all municipal supplies covered by (1) plus softening of municipal supplies that are excessively hard but meet U.S.P.H.S. standards. The difference in treatment facilities required under the two levels and hence cost is most noticeable in Mills County where ground water quality os comparatively good except for excessive hardness.

TABLE VII-15

MUNICIPAL ONLY VS. RURAL-URBAN TREATMENT COSTS

County	Municipal Only		Rural-Urban		
	USPHS only[1]	Total[2]	Plan I	Plan II	Plan III
Washington	7,912,000	7,912,000	7,579,000	6,949,000	11,532,000
Harrison	4,222,000	4,512,000	12,716,000	7,241,000	
Pottawattamie[3]	7,179,000	7,179,000	21,179,000	-[4]	-[4]
Mills	5,908,000	8,865,000	14,978,000	10,235,000	-[4]
Cass	6,100,000	7,418,000	8,326,000	5,340,000	6,694,000

[1]Treatment of supplies high in iron and/or manganese only.

[2]Treatment of excessively hard supplies in addition.

[3]Exclusive of Council Bluffs.

[4]Served by metropolitan area treatment plants.

SECTION VIII

EFFECT ASSESSMENTS

SECTION VIII

EFFECT ASSESSMENT

GENERAL ASSESSMENT

A general assessment of the effects on and by the alternatives and concepts discussed in this report is presented below. The first consideration is given to the broad effect-relationship of integrated water resource and land use planning. This is followed by commentary on the various structural and non-structural concepts.

Planning Considerations

The purpose of this study has been an inspection of four future growth patterns and their relationship to water supply, treatment, storage and distribution requirements. Water demands have been calculated for each of the future alternatives and various water system schemes have been proposed. Additionally, concepts for reducing water demand have been explored. This exercise will have value in the sense of supplying flexibility to the consideration of water system expansion. As future growth in the Omaha-Council Bluffs area begins to follow one of the four basic growth concepts, water system administrators can be alerted as to the various needs and requirements which can be expected.

Planning for Results. The real value of planning, however, is not to prescribe methods for adapting to future situations, but to provide strategies for shaping future conditions into patterns which are most desirable. Any urban-suburban-rural settlement pattern will have plusses and minusses. The basic goal of planning is to maximize positive qualities and minimize negative ones to achieve a most desirable net situation. Planning can rarely provide a single best answer, however. As time progresses, policy makers must make many decisions, utilizing all resources and input available, to guide growth and development in the desired direction.

The question, then, is not "How do we respond to a certain growth pattern?," but "How do we guide growth in a desired direction using the many tools and resources which are available?"

Plan Implementation Tools - The Role of Water Service. Zoning is considered by many to be the basic if not only tool for implementing land use plans. It is true that a well written ordinance enforced by able administrators can go a long way toward bringing a plan to fruition. In reality, however, zoning is most often limited to protecting the values and rights of existing homeowners. Individual rezoning petitions are usually considered on their own merits

rather than in context of a larger plan or with other recent and pending zoning decisions. The sum total effect of individual zoning cases will be a factor of the possible capricious actions of future elected officials. Most large scale real estate developers admit that zoning is one of their last considerations in the development of a specific site or tract of land.

The provision of basic municipal services can go much further than zoning in terms of guiding future growth and development patterns. Areas which have minimal or no basic services simply will not be developed except by those who either do not desire services at that location or who can develop their own services. Only a small minority of people fall into this category; furthermore, laws can and do serve to restrict such actions. On the other hand, development will tend to be encouraged in areas which are provided with a full range of services.

Water treatment and distribution is a basic municipal service. Water service cannot and should not be used by itself, though, to control and guide land development. It can be effectual, however, when used in concert with other services such as sewers, solid waste collection, police and fire protection, transportation facilities, and schools. Additionally, taxing policies can also guide development.

Innovative concepts such as reduced property tax contracts with farmers can prevent prime agriculture land from premature development and put a damper on reckless land speculation.

The importance of water service as a tool to guide and control development increases as water availability decreases. In the West, where projected water demands actually surpass the capacity of traditional supplies,in the near future, water will play a significant role. In the seven-county study area, the relative abundance of water (and the increasing number of individual water systems) serves to lessen this influence. In fact, this abundance of water relative to other sections of the country may serve to precipitate population growth far in excess of current projections. Should this happen, the importance of making wise water policy decisions, in coordination with other basic services, will increase greatly.

Individual water system administrators should neither have the burden nor take the initiative of making growth control related decisions in the absence of 1) a broad regional, public growth policy, 2) coordination with other water service providers, and 3) coordination with other services. Individual and isolated policy making will tend to fragment and possibly thwart efforts to implement a rational plan of growth and development.

Relationship of Housing Density and Water Use

Two principal features exist to differentiate among the four alternate growth patterns under consideration: location of land development and density of residential development. Both factors can impact on water system planning. Locational factors influence proximity to water source and hence distribution system requirements. Location itself does not affect levels of water use.

A relationship does exist between residential density and water use, however. The most significant factor in this relationship is the extent of lawn sprinkling which occurs. In high density development, the amount of grassed and landscaped areas per person or unit is quite small. In low density residential areas, the amount of yard area (and effort to keep it green) is large.

On the average, a person living in a high density situation (7 units or greater per net residential acre) uses approximately 20% less water than a person living at low density (2 units or less per net residential acre). Since lawn watering is seasonal, the differential in water use rates during peak periods in the summer would be much greater than the 20 percent. Water use rates computed on a per unit rather than per capita basis would serve to widen the high-low density differential since family size tends to be larger in low density areas and smaller in high density situations.

As presented earlier in this report, estimates have been calculated for residential per capita water use rates for each of 3 housing density ranges. These estimates are as follows: (1995 rates) low density - 78.0 gallons per day; medium density - 70.8 gallons per day; and high density - 61.8 gallons per day. Additionally, new growth represented by each of the four development patterns has been interpreted in terms of expected population mix among the three housing density groups.

With this information, water use load factors can be estimated and the effect of housing density can be identified. Table VIII-1 below summarizes the variation in water use among the four growth concepts due to residential density differences. Concept A, which represents a continuation of past growth and development trends, has been used as a base line for comparison. The information in Table VIII-1 concerns only new, residential development which will occur between 1974 and 1995.

TABLE VIII-1

Comparison of Growth Concepts:
New Residential Growth Water Use - 1995

	Water Use - Percent Differential From Growth Concept A		
	Concept B	Concept C	Concept D
Average Day	- 4.9%	- 6.6%	- 1.0%
Peak Day	- 9.3%	-12.1%	- 2.0%
Peak Hour	-10.9%	-14.0%	- 2.0%

Source: HDR

As is evident by the above table, the higher residential densities implicit in growth concepts B and C definitely result in lessended water demands. Of particular interest is the wide variation in peak hour loading and its implications on system design. In new growth areas which will be predominately residential, density of development will therefore significantly effect water quantity demanded and system design.

In the aggregate situation, though, these differences become less distinct. Inclusion of commercial, industrial, and existing residential water users decreases the differentials indicated in Table VIII-1 to a point where they lose significance. The relationship between

water demand and housing density thus has limited value for system-wide, area planning but can be quite important in sub-system, sub-area planning.

The Effects of Pricing Policy

The primary effect of water price changes, as discussed earlier, is a change in water demand. In general, a water price increase will result in decreased demand. The resultant demand decrease would therefore have the effect of postponing certain water system expansions that may otherwise have been necessary. Water pricing policies may also produce secondary socio-economic effects.

Direct Impact on the Poor.

A primary concern is the impact of price increases on the lower income residents of the study area. A price increase applied to the prevailing decreasing block rate schedule would impact heaviest on the lower income. Because lower income families and individuals tend to have fewer water using appliances and smaller yards, water use will fall in the highest rate category. The advantage of lower rates for higher volumes is thus not realized. Furthermore, a greater proportion of these person's income must go to providing necessities. A small or non-existent percentage of income exists

for discretionary purposes and hence available to absorb the increased cost of necessities. The fact that many lower income people, especially the elderly, are on fixed incomes worsens the impact during periods of generally rising prices.

If a water price increase was instituted in conjunction with a revised rate schedule, however, impact on the poor could be minimized or even prevented. A price increase incorporated into a schedule of fixed or increasing block quantity rates would not only produce greater demand reductions but would also be more equitable in that the high volume user would no longer be subsidized by the low volume user. Under such a rate schedule it is possible that the low quantity, lower income water user would not be presented with higher water bills.

Introducing a water price increase that does not impact on the poor would contribute toward maintaining the viability and livability of the study area communities. Adding to the monetary demands of the poor only serves to heighten tensions, invite crime and increase housing overcrowding, conditions which accelerate core city blight and urban sprawl.

Impact on Jobs and Income. It is doubtful that a water price increase would have significant impact on existing high quantity industrial water users in the sense of decreased production (and hence employment) or cessation of operations. Those industries which do not adopt water conserving practices will recover the increased cost of production through higher prices. The local impact of such actions could be negligible, however.

Higher industrial water rates could have the effect of discouraging certain large quantity water using firms from locating in the area. This in fact may be a desired goal of such an increase. It is felt that the area has sufficient attributes to attract other types of industry to maintain a health employment situation. Discouragement of large quantity water users could also result in the desired effect of lessening wastewater discharges.

Public Reaction and Acceptance

Probably the most expedient way to generate adverse public reaction and insure non-acceptance is to surprise the general public with an announcement that plans have been made and a course of action initiated. Although possibly true in the past, the general public no longer is totally disinterested in public affairs. Participatory planning in all functional areas is being realized as both a desirable and necessary ingredient for successful projects.

As the public becomes more involved in water resources planning, two basic groups will solidify. One group will be opposed to all action including planning itself. In this case, the government (or agencies thereof) will be perceived to be unnecessarily intervening with and infringing upon public rights.

The other group will be highly supportive of planning and concerned that actions (or inactions) should be taken which improve the general quality of life and which are sensitive to the natural environment. This group can easily neutralize itself, however. For example, support of a project that lessens the requirements for treated water may be offset by concern over non-water related impacts of developing the facilities involved.

For both groups, it is important to provide timely, accurate and complete information. This will counter balance biased and erroneous opinions in the first instance and help in weighing costs and benefits in the second.

Water Conservation. It is somewhat inappropriate to consider the public acceptability of water conservation attitudes since

these attitudes represent a measure of acceptance. Little effect can be expected from a water conservation program, however, if something less than a total effort is made. It is not hard to find strong advocates and participants of a conservation program who individually and privately fail to recognize that it also applies to them.

A successful water conservation program would probably produce the greatest benefits for the least cost than any other use reduction method. When use reduction is voluntary, there is basic assurance that no one person, family, business or industry is receiving inequitable, adverse impact.

When attitudes toward water conservation do not produce results, other non-voluntary measures may need to be introduced. Whereas total use reduction may be more definite, assurance that the program is not impacting hardeston those who can least take it is lost in the tradeoff.

Acceptance of Water Reuse. As presented earlier, the acceptance of reclaimed water varies greatly depending on the specific use under consideration. Predictably, greatest opposition is to personnel consumption and the least opposition is to outdoor non-consumptive uses such as road construction and grass watering.

It is evident then that planning for water reuse must clearly identify the uses to which it would be applied.

Although water reuse has been termed the "resource of the future," the engineering and scientific community appears to be almost equally divided for and against the concept. In terms of public acceptance, though, negative arguments most easily prevail. Current successful projects and rapidly advancing technology are easily neutralized by past examples of outbreaks of disease or poisoning from water supplies and from admitted unknowns regarding the effect of certain viruses, bacteria, parasites, and chemicals.

Public acceptability would also tend to vary depending upon the source of wastewater. Fosil fuel power plant cooling water discharge is essentially unchanged from its raw water state except an increased temperature. Acceptance to this form of wastewater would therefore be positive.

HEALTH CONSIDERATIONS

Impact of Chlorine Shortages

Prior to 1973, a general surplus of chlorine existed within the United States. Late 1973 saw the first indications that chlorine demand for purposes of disinfection might exceed chlorine supply. These early indications were realized in 1974, when the chlorine supply available often was inadequate to meet the amount of chlorine demanded.

Within the United States, many cities are presently forced to operate at a chlorine deficit, with one Southwestern City operating near a twenty-five percent deficit in hypochlorite supply. It is often necessary for municipal wastewater treatment plants to reduce the level of chlorination for effluents discharged to non-recreational waters, so that plants which discharge to water courses supplying water treatment plants will be adequately able to disinfect their flows.

It is often the case also, that municipalities recently have not been able to attract bidders to supply needed chlorine unless large price increases and the right to renegotiate prices on an, at least, quarterly basis are granted to suppliers. Many experts feel the expected unusual increases in chlorine demand are the result of new state and federal legislation requiring wastewater disinfection prior to discharge.

In view of the fact that, at most, no more than half of the nation's wastewater treatment plants currently chlorinate, the impact of these new regulations on total municipal chlorine requirements will be quite sizeable.

The Environmental Protection Agency estimates that total sanitary usage of chlorine in 1973 was 460,000 tons. This total comprises 250,000 tons for water supply, 187,000 tons for wastewater treatment and 21,000 tons for swimming pools. According to the Chlorine Institute, this total amounts to 4.5 percent of the nation's chlorine gas production, and 9.75 percent of its total shipments of liquid chlorine. According to the Environmental Protection Agency, 58 shortage/outage incidents have occurred in United States water and wastewater facilities since May 30, 1974. Of these incidents, 30 have been actual shortages and 23 of these have occurred at wastewater treatment plants. The chlorine shortage is expected to continue into 1976, when planned chlorine production will again exceed demand.

Another unresolved question in the chlorine situation is the element of the public health question. The recent surge of concern over potentially carcinogenic compounds in drinking water has shown dramatically the lack of knowledge in this area. An estimated 1000 tons

of chlorinated organic compounds, some known to induce cancer in laboratory animals, are discharged annually into the nation's waterways as a result of chlorination of wastewater. The ultimate impact of these chemicals discharge can only be speculated upon.

Alternatives to chlorination do exist, although each has its own inherent advantages and disadvantages. Until further research is carried out, however, it appears that chlorination will be the disinfectant method practiced at a majority of water treatment plants and wastewater treatment facilities for the foreseeable future. Therefore, this nation must do everything practical to be sure water treatment facilities are supplied with an adequate quantity of chlorine to carry out the function the facilities were designed for - the protection of public health.

Ground Water Contamination

Ground water contamination through seepage from individual, on-site Sewage Disposal Systems is a potential problem within portions of the Omaha-Council Bluffs Metropolitan Area. Other areas of the country have experienced this same problem within the past decade, and care should be taken within the Study Area to alleviate this potential problem before it is allowed to develop.

Generally, ground water can become contaminated through waste-water introduction in areas where the ground water level is high or where population densities become so great that soils are unable to handle loads from individual waste disposal systems. These parameters are both present in areas adjacent to the Platte and Elkhorn Rivers.

During the last few years, some residential developments have been constructed along the two waterways. These homes are often only utilized during the summer and fall seasons and stand vacant for the remainder of the year. These developments are characterized by medium density, with as many lots as possible being given river frontage. Homes are constructed with individual water supplies and waste disposal systems. Minimum Nebraska State Health Department Standards call for a distance of not less than 150 feet to separate well and disposal system, with the well to be constructed on the upgrade side of the lot.

These standards, though usually fine for single instances, often prove inadequate for developments with a concentration of dwellings. If the soils become saturated through over-use, the liquid wastes rise to the surface where they can drain into surface water courses and contaminate the surface stream. Another pollutional possibility would be

for the liquid to leach through the soils into the ground water itself. If this pollution occurs to the high side of the ground water flows, any individual water supplies to the low side could become unfit for human consumption.

Generally, these problems can be avoided before they occur. Wise development of raw land is a must and, if high densities of population are allowed to occur then adequate waste disposal systems must be implemented if the contamination of ground water supplies is to be avoided. Preventative measures can be employed before any development occurs. In this manner, ground water supplies will be available for their best beneficial use in future years.

REGIONAL CONSIDERATIONS

The rural-urban water supply concepts developed in Section VII of this report present alternatives which are sensitive to various metropolitan growth configurations and which assume varying degrees of regionalization. On one extreme, the seven-county study area is partitioned into approximately 30 rural water districts in addition to each of the existing municipal water systems. This has been presented as Concept I and represents current water system and subarea planning.

On the other extreme, Concept III envisions a broad regional approach with a minimum number of supply and treatment facilities (six), complete interconnection of distribution networks, and large segments of rural areas supplied by basically urban water systems. Concept II is a hybrid of Concepts I and III, retaining an amount of distinction between urban and rural areas but reducing the number of rural area treatment plants from 23, as in Concept I, to 8 facilities with service areas generally conforming to county boundaries.

The most devious distinction among the basic concepts is system physical configuration. Greater regionalization results in fewer numbers of supply and treatment facilities increase in size, their unit costs go down. Regionwide water systems therefore benefit from economies of scale.

Cost is not the sole criterion for evaluating alternative water supply and distribution concepts, however. Other factors which enter in varying degrees into the decision-making process are discussed below.

Administrative and Technical Management

Just as with capital requirements and operation and maintenance

expenses, certain economies in professional staff and clerical costs can be achieved in a regional water system concept. Although the average number of staff in each of the larger systems would increase, the total number of administrative, technical and clerical personnel throughout the study area could be lower, hence lower overall costs. Larger operations can also lead to economics in billing and data processing requirements through the use of computers.

In addition, it is conceivable that the quality of top management in the larger, regional systems would be higher than the average in a larger number of smaller systems simply because of the ability to pay higher salaries to attract talented individuals. This aspect could be neutralized, however, by personnel and organizational inefficiencies which tend to be more prevalent in larger organizations. A smaller organization tends to be more responsive to customers, policy makers, and internally, to itself. Largeness is therefore no guarantee that managerial efficiency and effectiveness will result.

System Reliability

Water is a commodity which modern society expects to be provided

in a reliable fashion. Not only do we expect water to flow when the faucet is turned, but we also demand that it meet health standards, be of uniform quality (especially for certain industrial processes), be sufficient to fulfill fire fighting requirements, and maintain a desirable pressure.

Basic design and mechanical factors which enter into system reliability are 1) reliability of the source itself to have a sufficient quantity of water, 2) treatment quality control, 3) equipment capabilities including standby pumping capacity, 4) back-up energy capabilities and 5) adequate storage facilities. In addition, capable and adequately trained administrators and operators are necessary for total system reliability.

The size of a water system does not necessarily dictate its state of reliability. However, the costs and technical requirements of maintaining legislated and recommended operation standards can become prohibitive for smaller system operations. The result may then be that the system does not meet one or more of the above mentioned reliability factors.

A survey of the approximately 50 municipal water systems in the seven-county study area (see Table II-16) indicated a significant

potential deficiency in system reliability throughout the area. Fifteen of these non-metro, municipal systems have inadequate supply capacities, 26 have inadequate storage capacity, and at least 16 have no auxiliary standby facilities.

It is reasonable to speculate, therefore, that the formation of a large number of independent, rurally based water systems, as in Concept I, would increase the potential for system reliability deficiencies. The probability that larger systems would have greater financial and technical capabilities indicates that a more regional approach to water service provision would yield greater overall system reliability to the seven-county area. For example, larger facilities can be designed with multiple units permitting units to be taken out of operation for repair and maintenance without affecting levels of service. Also, as envisioned in Concept III, interconnection of regional distribution systems provides a capability of total supply and treatment facility backup, a concept similar to the power grids common in the electric utility industry.

Policy Setting, Planning and Growth Impact

It has beenstated earlier that organizational responsiveness would tend to be greater in a smaller water system. Likewise, policy

setting and planning within a sub-area system also have the opportunity of being more reflective of that sub-area's service population desires than in larger systems, especially when the sub-area is rural in character and the larger system is predominantly urban based. These potential benefits could come at the expense, however, of a rational and uniform region-wide water policy. While responsiveness of policy-makers to their constituents is unquestionably desirable, the immediate concerns of a sub-area may be counter-productive in the regional context and ultimately to the sub-area itself.

The scheduled provision of water service in certain areas and in certain quantities can contribute positively to the implementation of a regional growth concept. Conversely, the mass, unscheduled provision of water throughout the rural hinterland of a metropolitan area can facilitate large scale urban sprawl and thus void a planned growth concept. Regional planning tends to be most effective when the large scale improvements of utilities and transportation systems are implemented and operated on a regional or sub-regional basis.

When water service forecasting is conducted on a sub-area basis, a much greater variance in accuracy can be expected than when conducted on a regional scope. It is therefore likely that implementation

of the numerous independent rural water districts envisioned in Concept I could precipitate population, commercial and industrial growth which outstrips the capability of individual systems to provide adequate levels of service. Furthermore, the growth which could be induced by the widespread provision of water systems in currently rural areas could place a burden on small towns and counties to provide other services such as recreation, police and fire protection, and solid waste collection of which they are not capable of adequately providing.

Rural Water District Implementation

This study assumes that rural water districts of some form will eventually be created to serve all non-metropolitan counties in the study area. The existence of four county-wide studies, a 1974 study for a portion of Washington County, and RWDs in construction and preliminary design stages in Cass County supports the validity of this assumption.

Public demand for adequate supplies of good quality water will be the determining factor in the extent and timing of rural water district implementation. Compared to metropolitan municipal users, cost of water to rural users will be expensive due to the large capital investment per customer. However, indications are that people are

willing to pay average water bills of $20 per month and up to obtain rural water service. Average monthly billings in Cass County RWD 1 and Otoe County RWD 3 which are under construction are expected to be about $15 and $21/month respectively. The Papio N.R.D. Rural Water System study of Washington County recommends an alternative with an average monthly billing of $23 per month. Initial response to the N.R.D. report has been generally favorable with objections to price raised only by those residents currently having an ample supply of good quality water.

Table VIII-2 presents a comparison of rural water districts proposed in this study with other districts in Iowa, Nebraska, and South Dakota. Comparisons drawn from this table should be of only a general nature since costs and usages from the Page County and Papio N.R.D. reports are the result of surveys to determine interest and needs of area residents and detailed engineering to provide cost effective service the greatest number of interested users. Usage projections for this study are based upon a composite of information taken from other reports dealing with specific portions of the study area. Cost estimates contained herein are derived from general distribution system layouts designed to serve the entire county population with the intent of evaluating alternative source considerations.

TABLE VIII-2

RURAL WATER DISTRICT COMPARISON

District	Construction Cost per Rural User	Average Monthly Billing	Av. Gallons per Month per Rural User
Page Co., Iowa	$3,920	$25	5,000
Hospers, Iowa	$4,800	$37	17,700
Lucas Co., Iowa	$3,170	$20	7,400
Wayne Co., Iowa	$3,870	$20	7,600
Otoe #3, Nebraska	$3,370	$21	6,000
Charles Mix, S.D.	$3,620	$21	8,000
Cass #1, Nebraska	$2,200	$15	6,000
Papio NRD, Nebraska			
Alt. 1[1]	$2,120	$13	8,600
Alt. 2	$5,520	$38	12,600
Alt. 3	$5,040	$34	9,400
Alt. 4	$2,700	$23	12,000
Plan II			
Washington Co.[2]	$3,550	$20	9,600
Harrison Co.	$3,600	$25	9,000
Pottawattamie Co.	$4,030	$25	9,900
Mills Co.	$6,070	$26	9,000
Cass RWD #3	$5,160	$31	9,300

[1]Includes Blair

[2]Excluding area served by Papio NRD alternate 4.

Source: Preliminary Report for a Water Supply and Distribution System, Page County, Iowa, 1974, Bartlet and West Consulting Engineers; Papio N.R.D. Rural Water System, 1974, Dana, Larson, Roubal and Associates; HDR

Construction cost per rural user varies from $2100 to $5500 in other districts and $3600 to $6000 in this report. Supplying all county residents as well as livestock demands as assumed in this study inflates construction cost. Average monthly billings taken from the other studies range from $13 to $38 per month compared to $20 to $31. Average monthly billings computed from costs generated in this study are for all county residents rather than computing separate rates for city and rural based upon capital expenditure differentials. Assumption of a $1000 hookup fee (compared to $800 to $900 for Papio N. R. D. alternates) for rural residents only helps maintain investment equity between rural and incorporated areas.

Average daily per capita water consumption for rural and village users is assumed to increase from 60 to 100 with rural water district implementation. This increase, while substantial, is the general trend indicated in other reports. Readily available, high quality water is bound to encourage water usage especially for those having an inadequate supply prior to RWD service. The relatively high cost of water would appear to be a serious deterrent to increased consumption until a typical rate structure is examined. Rural water district rate structures are usually comprised of a high minimum billing with a rapidly decreased block rate thereafter. This makes the incremental cost of water usage above the minimum low, and, indeed, additional water might be regarded as "cheap" by the user.

For instance, minimum monthly billings for Cass Co. RWD 1 and proposed Papio N.R.D. alternate 4 are $6.50 and $10.50 respectively, for up to 1000 gallons. Assuming a household of 3.2 people, monthly usage would increase from 5,760 to 9,600 gallons with a per capita rate rise from 60 to 100 gpd. This 67 percent consumption rate increase would be accompanied by only 29 and 34 percent monthly billing increases under the Papio and Cass rate structures. Comparable usage increase in the MUD system would result in a 42 percent billing increase, and in Council Bluffs, 50 percent. Thus it is felt that benefits accrued from increased consumption, monetary or otherwise, will outweigh the increased utility fee.

Monetary benefits of rural water district implementation, while very apparent to a farmer faced with drilling a new well or treating his own supply, are generally hard to determine precisely. Health and aesthetic considerations as discussed earlier in this report favor rural water districts over most existing private suppliers. Improved livestock productivity is suggested in a referenced report as a monetary benefit. Industrial and recreational development induced by water quality and availability would be a boon to rural area economy.

Riverfront Development New Towns

Costs, other than treatment, of serving the new towns of Deer Creek, Florence Precinct and East Bellevue under Plan II, are summarized following:

	Florence Precinct & Deer Creek	East Bellevue
Capital Expenditure		
Total to 2020	$5,309,800	$4,569,300
Per User	$ 1,890	$ 2,090
Operation & Maintenance		
Annual		
1995	$ 31,200	$ 46,600
2020	$ 50,900	$ 47,400
Annual per user		
1995	$ 14.30	$ 21.30
2020	$ 18.10	$ 21.70

These costs vary somewhat from Plan to Plan with treatment costs depending upon the supplying utility (see Table VII-2). An important consideration, especially in the case of the Washington County towns of Deer Creek and Florence Precinct, is that the above costs are based upon planning for development of these communities in initial rural water system construction. Uncertainties regarding the future of the new town concept may cause these towns to be disregarded in water system design (as in the Papio N.R.D. study) resulting in costly distribution system expansion or construction of new supply and treatment facilities.

Resource Utilization

The goal of regional water supply planning is development of a plan which optimizes the use of all available resources. Use of non-traditional water supply sources and dual potable-nonpotable water systems are considered as a means of optimizing use of water resources. Cost considerations presented in Section VII preclude use of dual water systems in the study area. Water availability problems dictating use of alternative water sources or serious water quality problems requiring additional costly treatment steps such as dissolved solids reduction or organic compound removal do not exist in the study area at this time.

Chemical

Water treatment chemical usage in the metropolitan area is a function of water usage and raw water source. As presented in Table VII-2 chemical costs for treatment of a major metropolitan plant increase from $13/mg for treating Platte Valley groundwater to $18/mg for treating Missouri River water to $24/mg for treating Missouri River valley groundwater. Average metropolitan chemical costs per million gallons treated in 2020 are summarized in Table VIII-3. Plan II reflects the lower chemical usage in treating Platte Valley groundwater. Average costs are lower for Growth Concepts A and D since a larger proportion of water needs are met by the Platte West plant in

the sprawl concept. Plans III and I alternate 2 assume a ground water source while Plan I alternate 1 assume a surface water source at the Missouri South Plant.

TABLE VIII-3

AVERAGE METROPOLITAN AREA CHEMICAL COSTS

($/mg)

Plan	I Alt. 1	I Alt. 2	II	III
Growth				
A	18.90	20.60	17.10	20.20
B	20.00	20.50	17.60	20.10
C	18.90	20.30	17.40	19.80
D	19.00	20.70	17.20	20.30

Chemical usage in the non-metropolitan area is also a function of source and quantity treated but treatment plant isze also becomes a factor. In general, smaller plants make less efficient use of treatment chemicals. Increased unit chemical cost for the smaller quantities purchased by smaller plants also increases chemical cost per mg treated. Average chemical costs per million gallons treated for non-metropolitan areas are summarized in Table VIII-4. All areas with exception of Washington County have significant chemical savings due to increased regionalization and centralization along the Missouri River in Plan II versus Plan I.

TABLE VIII-4

AVERAGE NON-METROPOLITAN AREA CHEMICAL COSTS
($/mg)

PLAN	I	II	III
County			
Washington	$35	$35	$35
Harrison	$75	$35	$35
Pottawattamie	$75	$35	$35
Mills	$49 Alt. 1 $44 Alt. 2	$35	$24
Cass RWD #3	$31	$20	$20

Energy

Another resource utilized in the treatment and distribution of water is energy. Pumping of water from source to treatment, treatment to distribution system, and booster pumping within the distribution system accounts for the majority of energy consumed although a variety of electrically driven devices are used in water treatment including mixers, and process pumps.

A major factor in minimizing the quantity of electricity (and other fuels on a standby basis) used is reduction in the number of times water is pumped between source and user. For instance, in the MUD system low lift pumps at the Florence River intake and well pumps at the Platte

well field pump raw water to treatment. High service pumps supply a lower elevation direct system and intermediate reservoirs with treated water. Booster stations repump water from the direct system and reservoirs to serve higher ground areas. One existing and a second planned pumping station in western Omaha pump the water a fourth time during peak demands to maintain satisfactory pressure in all portions of the system. As indicated in Table VIII-5, a Platte West plant as in Plan II located at a higher elevation and with more direct access to developing western Omaha areas minimizes energy costs by reducing the amount of repumping required. Costs in this table are derived from treatment and primary pumping power and fuel costs listed in Table VII-2, a MUD booster pumping power cost of $18 per mg and a Council Bluffs and other pumping station power cost of $20 per mg.

TABLE VIII-5

AVERAGE METROPOLITAN ENERGY COSTS

	($/mg treated)			
PLAN	I Alt. 1	I Alt. A	II	III
GROWTH				
A	31.50	31.10	26.80	31.00
B	31.70	29.80	28.20	28.70
C	30.10	29.60	27.10	29.60
D	31.10	30.70	26.40	30.60

Non-metropolitan area average energy costs listed in Table VIII-6 are based upon a treatment and primary pumping power cost of $30 per mg for treatment plants less than 5 mgd capacity and a $20 per mg power cost for larger treatment plants and booster pumping stations. Energy costs rise sharply from Plan I to Plan II in Harrison and Pottawattamie Counties where in each case a single treatment plant replaces numerous small plants scattered throughout the county. Thus energy consumption is sacrificed for conservation of chemical resources in increased regionalization due to the repumping required to move water across a county.

TABLE VIII-6

AVERAGE NON-METROPOLITAN ENERGY COSTS

PLAN	Growth	($/mg treated) I	II	III
Washington	E	32.50	31.00	32.50
	B	28.80	25.90	28.80
Harrison	E	34.60	41.70	45.00
	B	33.40	41.30	43.70
Pottawattamie	All	37.40	57.80	57.80
Mills	E	45.70	48.90	45.00
	B	49.30	50.00	50.10
Cass RWD #3	All	46.20	54.40	54.40

Land

Land area required for treatment plants is not a major factor in most cases. However, well fields along the Missouri and Platte Rivers require up to 9 acres per mgd capacity and in other areas up to 20 acres per mgd capacity when access roads, well spacing and purchasing of parcels are considered. As previously mentioned, an alternative to lagooning of waste streams has been assumed in treatment plants larger than 2 mgd due to land considerations. Treatment plant expansion in the immediate vicinity of the Florence plant is limited due to land availability. Location of a Missouri River South plant is perhaps the most crucial land utilization consideration. A Gifford Peninsula site as proposed in the MUD master plan would require careful consideration of environmental aspects associated with development of a nature center in this area. While careful planning and attention to construction and operation details could make the two land uses compatible, land availability and aquifer capacity at the more southerly alternative site of the MUD master plan warrants initial consideration.

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